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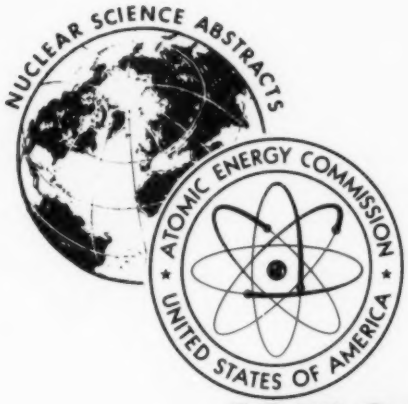

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February 28, 1965

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The following papers were not available in printed form and did not appear in *NSA:*

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NUCLEAR SCIENCE ABSTRACTS

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NUCLEAR SCIENCE ABSTRACTS

BIOLOGY AND MEDICINE

General

5598 (NYO-3291-1) EFFECTS OF MAGNETIC FIELDS ON CERTAIN BIOLOGICAL SYSTEMS. Final Summary Report, October 31, 1963–October 31, 1964. Brenda G. Foner (Boston Univ. School of Medicine). Nov. 22, 1964. Contract AT(30-1)-3291. 21p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Results are summarized from a number of studies on the effects of magnetic fields on selected biological systems. Low fields ranging from 1700 to 3000 gauss were produced by permanent magnets of the magnetron type with vertical pole faces and high fields of up to 92 kgauss were produced by Bitter type selenoids. Data are presented on the effects of magnetic fields on the agglutination of human erythrocytes with homologous antisera and lectin, a plant agglutinin, under various conditions of oxygenation and temperature; the effects of magnetic fields on blood sedimentation rate; the effects of magnetic fields on the displacement of blood cells and particles of finely ground chalk in suspension; and the effect of a magnetic field on the rate of formation of a precipitate by hemocyanin from the blood of a snail, Busycan canaliculatum, and antihemocyanin prepared by standard methods in a horse; and the effects of a magnetic field on electrocardiogram readings of mice. Applications of the findings in studies of the possible effects on astronauts of the magnetic shielding against cosmic radiation are discussed. (C.H.)

5599 STUDY OF THE AGRICULTURAL PROPERTIES OF SOILS BY MEANS OF POWDERED RADIOACTIVE PHOSPHORUS COMPOUNDS. C. L. Lee, T. Y. Tsio, and J. Gee. K'o Hsueh T'ung Pao, No. 7, 638-9(1964). (In Chinese)

During 1962 and 1963 tests were carried out with radioactive P compounds, such as calcium phosphate, by applying the radioactive material on limestone-base, acidic, and clayey soils, in which beans, corn, and wheat were planted. Use of mixtures including calcium perphosphate in red, acid, clay-containing soils resulted in an increase of production. The experiments were useful for determining the inhibiting action of certain types of soils. The same mixture was found to be without any effect when added to limestone-containing soils. Similar additives were used also for organic fertilizers, making the addition either immediately prior to the treatment of the soil with the mixture or after the organic fertilizer was undergoing fermentation. No changes were observed in either case in the yield or in the P content of the plants. (TTT)

5600 CALCULATED ABSORBED DOSE FOR ELECTRONS. N. D. Kessaris (Sloan-Kettering Inst. for Cancer Research, New York). Radiation Res., 23: 630-40 (Dec. 1964).

The depth-dose distribution for plane monodirectional electron beams of energy 10 to 20 Mev incident in water was mathematically calculated, and explicit mathematical solutions were obtained that take into account the production and absorption of bremsstrahlung and the effects of secondary electron production. In addition, the bremsstrahlung production spectrum, averaged over spatial variables, has been calculated. The calculations were carried out for three beam energies, 39, 30, and 20 m_0c^2, corresponding to 20, 15.3, and 10.2 Mev, respectively. (auth)

Ecology

5601 (IAEA-R-19) STUDIES OF RADIOACTIVE CONTAMINATION IN LOCAL MARINE RESOURCES. Final Report. Yasuo Miyake (Tokyo Kyoiku Univ. Inst. of Inorganic Chemistry), Yoshio Sugiura, and Toshio Nan'niti (Meteorological Research Inst., Tokyo). [1962]. Contract $19R_1/RB$. 137p. Dep.(mn).

A basic study concerning the radioactive contamination of the local marine resources was done. As the observation site Suruga Bay located on the Pacific side of Honshu was chosen. The observation was carried out twice in July 1961 and September 1960 aboard the research vessel SHUMPU-MARU (the Spring Breeze, 150 tons) which belongs to the Kobe Marine Observatory. Current measurement was made respectively at 0, 100, 200, 300, 400, and 500-m layers. The depth of the observation site was 600 m and the bottom current 1 meter above the sea floor was measured with a new type of current meter. The results of current observation showed that there was a considerably fast current of about 10 cm/sec at the bottom which was caused by the turbulent flow. This suggests the presence of a large diffusive motion near the bottom. The eddy diffusivity of water in the bay was also calculated. As a result of analysis of observational data of other oceanographic elements such as water temperature, chlorinity, nutrient matters, dissolved oxygen and pH, it was found that there was an internal wave in the bay and water molecules were transferred by vortices which were formed by the superposition of the internal wave and the tidal current. It was also calculated that the residence time of the bay water was about one month near the surface and more than several months at the sub-surface. The vertical distributions of natural radionuclides (radium, uranium, thorium, and ionium) as well as artificial radionuclides (^{90}Sr and ^{137}Cs) in the bay were studied. The vertical profile of ^{90}Sr suggests a faster vertical mixing of water than ever thought to be. With respect to the enrichment factor of ^{90}Sr in marine organisms living in the bay, the value of 11–17 was obtained by the radio-chemical analysis of Sergestes lucens Hansen. (auth)

5602 THE CONTENTS OF RADIOACTIVE SUBSTANCES IN MILK. E. Knoop (Bundesforschungsanstalt fur Milchwirtschaft, Kiel). Landwirtsch. Forsch., 17: 23-31(1964). (In German)

The contamination of milk with radioactive ^{90}Sr, ^{137}Cs, and ^{131}I in the German Federal Republic up to the end of

1962 is surveyed. The admissible levels of ^{90}Sr and ^{137}Cs were not exceeded, but danger levels were reached for a short period of time with respect to ^{131}I. It is shown that ^{137}Cs levels measured by γ spectrometry within a few hours can be used for estimating with fair precision the amounts of ^{90}Sr in milk. (auth)

Metabolism, Tissue Distribution, and Toxicology

Refer also to abstract 5983.

5603 (BNL-8641) COMPUTER APPLICATIONS IN METABOLIC STUDIES OF $^{14}CO_2$ EXCRETION. Walton W. Shreeve (Brookhaven National Lab., Upton, N. Y.). Sept. 25, 1964. Contract AT-30-2-GEN-16. 9p. (CONF-754-5). Dep.(mn); $1.00(cy), 1(mn) OTS.

From International Business Machines Medical Symposium, Poughkeepsie and Upton, N. Y., Oct. 1964.

The appearance of $^{14}CO_2$ in the breath of diabetic and other patients after administration of selected labeled carbohydrates was used to characterize the extent and nature of metabolic abnormality caused by endocrine imbalance. With the development and present use of a continuous analyzer of ^{14}C and CO_2 in the breath together with apparatus for digitizing information from the electronic devices and transcribing it to paper punch tape, digital computer analyses can now be used to calculate the patient's output of $^{14}CO_2$ in terms of a convenient expression such as cumulative per cent of ^{14}C dose expired with time after administration. This can provide complete and accurate analysis of results promptly after a procedure which is presently experimental with a few patients, but which could be eventually employed on a much larger scale if technical facility allowed and if particular tests with ^{14}C gave promise of superior clinical diagnoses. The computer should eventually be useful also for analyzing differences between sets of curves, thereby guiding the design and selection of future studies, characterizing the dynamics of bicarbonate turnover in the body, and analyzing in detail the shape of $^{14}CO_2$ curves which could reveal metabolic periodicities and interrelationships that vary between healthy and diseased states. (auth)

5604 (HW-SA-3729) ZINC–CADMIUM INTERRELATIONSHIPS IN RATS AND SHEEP (thesis). Beatrice J. McClanahan (Washington State Univ., Pullman). Sept. 30, 1964. Contract AT(45-1)-1350. 99p. Dep.(mn); $3.00 (cy), 2(mn) OTS.

The uptake of ^{65}Zn by ovine erythrocytes and everted duodenal sacs obtained from rats did not appear to involve any metabolic processes under the conditions employed, as evidenced by the fact that the addition of metabolic inhibitors to the incubation media did not alter the uptake except in the case of sodium cyanide and sodium malonate in the ^{65}Zn uptake by erythrocytes. The presence of sodium cyanide in the incubation medium increased the uptake of ^{65}Zn perhaps by complex formation or by alteration of the permeability of the membrane. Sodium malonate diminished the ^{65}Zn uptake, probably by forming a complex with zinc which was not suitable for passage through the membrane. The uptake of intravenously administered ^{115m}Cd and ^{65}Zn by erythrocytes of sheep was increased when the concentration of zinc was increased to a maximum of 0.057 mmoles Zn/kg body weight. The increase in ^{65}Zn was greater at the highest level of zinc. This was apparent when the erythrocyte to plasma ratios were examined. The reverse was observed for ^{115m}Cd; at the highest level of injected zinc, the erythrocyte to plasma ratio for ^{115m}Cd was lower than at the other zinc dosages. These observations may be attributed to a change in the usual binding pattern in the plasma and/or to an alteration in the binding in the erythrocytes. A constant fraction of the administered dose of ^{65}Zn and ^{115m}Cd was transferred from plasma to milk in spite of a progressive reduction in the plasma clearance of each radioisotope when the amount of administered zinc was increased. When the milk secretion rate in ewes was reduced by allowing the udder to fill with milk, the transfer of ^{115m}Cd and ^{65}Zn from plasma to milk was reduced, suggesting that their transfer was related to secretion rate. The amount of zinc that was injected did not influence the transfer. Cadmium-115m and ^{65}Zn, infused into udders that had been allowed to fill with milk for 12 hours prior to infusion, rapidly disappeared from the milk to plasma. Exposure of rats to dietary zinc and cadmium for 14 days at levels of 2.8 and 1.6 mmoles/kg feed, respectively, singly and in combination, affected the ^{65}Zn and ^{115m}Cd content of liver, kidney, pancreas, small intestine including contents, and serum 4.5 hours after a single intraperitoneal injection of the radioisotopes. The concentration of ^{115m}Cd and ^{65}Zn in all the organs of rats analyzed one-half hour after an intravenous injection of varying amounts of zinc and cadmium in amounts up to 189 mmoles/kg or 24 mmoles/kg, respectively, revealed that both elements modified the ^{115m}Cd and ^{65}Zn contents of liver, pancreas, kidney, small intestine, testes, prostate, and plasma. Twenty-four hours after the treatments were applied, their effects on the ^{115m}Cd and ^{65}Zn concentrations were diminished, except in plasma, where the ^{115m}Cd concentrations at the higher levels of zinc or cadmium were still significantly higher than at the lower levels. (auth)

5605 (UCRL-Trans-1154) HYPOPHYSIS AND IRON METABOLISM. THE ABSORPTION OF Fe^{59} IN THE BONE MARROW, BLOOD AND VARIOUS ORGANS OF HYPOPHYSECTOMIZED RATS. M. E. Austoni, D. Ziliotto, and P. Carenza. Translated by Senta Pugh (Univ. of California, Lawrence Radiation Lab., Berkeley), from Wien. Z. Inn. Med. Grenzg., 37: 137-45(Apr. 1956). 17p. Dep.(mn); $1.60(fs), $0.80(mf) JCL.

The ^{59}Fe absorption in the bone marrow, blood, liver, spleen, and kidneys of hypophysectomized rats were studied by cyto- and histoautoradiographic techniques and scintillation counting after the endoperitoneal injection of trace elements of ^{59}Fe of high specific activity (0.25 μC per gram body weight). The medullary ^{59}Fe absorption was considerably lower for the hypophysectomized rats than for the controls and also slightly slower in time. In the blood, the activity curve was also slightly lower while the deposit organs showed practically no variations from normal. Only in the kidneys a certain tendency towards increased iron absorption was observed during the initial phases. (auth)

5606 THE BIOLOGICAL HALF-LIFE OF RADIOIODINE AS AN INDEX OF THYROID FUNCTION. D. Ziliotto (Universitá, Padua). Acta Isotopica, 1: 281-91(Dec. 31, 1961). (In Italian)

The determination of the thyroidal half life of iodine was done in 307 subjects, 55 of whom were normal and the rest affected by different diseases of the thyroid gland. A scintillation counter was used for determination of thyroid uptake at one and two hours, and one, two, three, and four days after the ingestion of 50 to 100 μC of ^{131}I. The ^{131}I urinary excretion and protein-bound ^{131}I in serum were also determined to check the accuracy of the results. The average thyroid half life values found were: control, 33 ± 43 days; exophthalmic goiter, 9 ± 8 days; toxic goiter, 13 ± 20 days; nontoxic goiter, 56 ± 63 days; thyrotoxicosis without goiter 12 ± 9 days; and hypothyroidism, 19 ± 32 days. The individual variations were so marked that it was not possible to establish any statistical conclusions; thus, the only valuable data obtained were the differences between normal, hyperthyroid, and nontoxic goiter. Since the uptake rate was in inverse proportion to the biological half life, it was concluded that the study of the biological half life of radioiodine could be of value for the study of the physiology of the gland. However, it is not very useful in clinical diagnosis because of the wide variations and the overlap of values observed in the different pathological conditions. (BBB)

5607 SELECTIVE ACCUMULATION OF RADIOACTIVE PHOSPHORUS IN VARIOUS DERMATOSES. J. Vilkki and A. Voutilainen (Univ. of Oulu, Finland). Ann. Med. Exptl. Biol. Fenniae (Helsinki), 41: 521-30(1963).

Twenty-five different dermatoses were investigated for ^{32}P selectivity. The test dose was 200 μC of radioactive sodium orthophosphate orally. Radiation measurements were effected by a beta window tube and by counting the impulses, which were compared with impulses from healthy skin. The majority of the dermatoses studied showed a selective accumulation of ^{32}P in the affected skin areas. The present material included only sarcoma Kaposi, erythrodermia exfoliativa and verrucae digitae which were not selective. The greatest selectivity was displayed by tuberculosis cutis, scleroderma (in the oedematous phase), ulcus cruris infecta, and dermatitis herpetiformis. Furthermore, it was found that the rate of elimination varied from one dermatosis to another irrespective of selective accumulation. Clinical improvement was observable in some cases. No adverse effects from the administration of ^{32}P were noted. (auth)

5608 THE INFLUENCE OF 5-HYDROXYTRYPTAMINE ON THE ABSORPTION OF TRITIATED WATER (HTO) FROM THE INTESTINE OF THE RAT. F. Lembeck, K.-Fr. Sewing, and D. Winne (Universität, Tubingen, Ger.). Arch. Exptl. Pathol. Parmakol., 247: 100-9(1964). (In German)

Abnormalities of water absorption in patients with the carcinoid syndrome, in which the secretion of 5-hydroxytryptamine (serotonin) is markedly increased, prompted a study of the influence of serotonin on the absorption of tritiated water (HTO) from the small intestine of rats in situ. Serotonin, given intralumenally (2.5 mg) or by intravenous infusion (5 μg/min), reduced the rate of water absorption about 50 %. This effect may be caused by a change in intestinal capillary blood flow or an inhibition of active water transport. When serotonin was infused intravenously, but not when it was given into the intestinal lumen, the concentration of HTO in blood was found to be higher than in the controls. This reduction of HTO space can be explained by concomitant vasoconstriction. These results are discussed in terms of the hypothesis that the delay of water transport by serotonin contributes to the occurrence of watery diarrhea in carcinoid patients. (BBB)

5609 THE INFLUENCE OF TEMPERATURE ON THYROID HISTOLOGY AND RADIOIODINE METABOLISM OF YEARLING STEELHEAD TROUT, SALMO GAIRDNERI. J. G. Eales (Univ. of New Brunswick, Fredericton, Can.). Can. J. Zool., 42: 829-41(Sept. 1964).

Because of conflicting data obtained earlier, the effect of temperature on radioiodine uptake of the thyroid was studied in this poikilotherm species. The thyroid/serum (T/S) ratio and the conversion ratio (CR) were measured in trout injected with 2 μC ^{131}I. The thyroid activity of the yearling steelhead increased with temperature from 6 to 18°C. The thyroid uptake of ^{131}I peaked at 12°C; however, this method was found unreliable, since plasma ^{131}I clearance, upon which it deptends, also increased with temperature. The staining reaction of the colloid (Azan stain) indicated greater thyroid activity at high temperatures. On the other hand, measurements of thyroid mean epithelial height implied greater activity at low temperatures. Thus, there are three discrepancies between methods for measuring thyroid activity, i.e. between (1) % dose in thyroid and the T/S and CR methods, (2) cell height and the CR and T/S methods, and (3) cell height and colloid color. The first anomaly can be resolved in terms of the simultaneous influence of temperature on the ^{131}I loss from the plasma and its uptake by the thyroid. To explain the second and third anomalies an hypothesis is presented. In homoiotherms, control of the thyroid is primarily via the anterior pituitary and the circulating level of thyroid-stimulating hormone (TSH). However, in poikilotherms, where the body temperature varies considerably, the thyroid may also respond directly to temperature. Thus the increased thyroid activity recorded in the steelhead at the higher temperature could be a simple thermal tissue response by the thyroid. The mediation of the anterior pituitary via an increase in plasma TSH is not necessarily involved in the response. (BBB)

5610 THE NEED FOR RESEARCH PROGRAMS TO PROVIDE DATA APPLICABLE TO THE ESTIMATE OF MAXIMUM PERMISSIBLE EXPOSURE VALUES FOR INTERNALLY DEPOSITED [RADIONUCLIDES]. Karl Z. Morgan (Oak Ridge National Lab., Tenn.). Ind. Med. Surg., 33: 496-7(July 1964).

A brief general discussion is presented of some problems developing concomitant to widening use of radionuclides in industry. In spite of the unparalleled hazards associated with ionizing radiation, this new nuclear industry is growing rapidly while at the same time maintaining radiation damage at an insignificant level. Although in the past few decades much more has been learned about the hazards associated with ionizing radiation than those associated with other industrial hazards, and although maximum permissible exposure levels for the radionuclides have been established with greater reliability and confidence than have the levels for many chemical agents used for many centuries, there still remains uncertainty in many of the basic assumptions and in the parameters used in the calculation of maximum permissible body burden and maximum permissible concentration of the various radionuclides in food, water, and air. It is pointed out that there is need to determine the uptake, distribution, and elimination of the 300 common radionuclides. These data are needed for the several modes of intake by the various age groups, and differences due to race, sex, weight, eating habits, etc., should be investigated. There is need especially to obtain data from studies of human exposure and to examine the influence of the quantity and chemical form of the radionuclide and of other associated chemical elements taken into the body, both from single exposure and from continuous exposure. (BBB)

5611 LONG-TERM ADMINISTRATION OF RADIOISOTOPES IN METABOLIC STUDIES (A COMPARISON WITH PURE CHEMICAL STUDIES). W. T. Binnerts (Agricultural University Coll., Wageningen, Netherlands) and F. W. Lengemann. Intern. J. Appl. Radiation Isotopes, 15: 513-16(Sept. 1964).

The labor requirements were calculated for a specific research object; a feeding trial with goitrogens in dairy cattle and estimation of the iodine secretion into the milk. The use of radioisotopes in this case proved to save 80% relative to chemical analysis. (auth)

5612 EVALUATION OF THE EFFICACY OF DIFFERENT METAL CHELATES OF DTPA IN REMOVING INTERNALLY DEPOSITED RADIONUCLIDES. Alexander Catsch, Du Khuong Le, and Danielle Chambault (Kernforschungszentrum, Karlsruhe, Ger.). Intern. J. Radiation Biol., 8: 35-43 (1964).

The effectiveness of Co(II)-DTPA and Zn(II)-DTPA in preventing the retention of radiocerium and radioyttrium by the organs of the rat was studied and found to be insignificantly diminished as compared with Ca-DTPA. The therapeutic index of both chelates, on the other hand, is greater than that of Ca-DTPA because of their low toxicity. The possible therapeutic use of these chelates is discussed. (auth)

5613 EFFECT OF DOUBLING THE ORAL INTAKE OF CALCIUM ON THE UPTAKE OF RADIOACTIVE STRONTIUM IN RATS. G. E. Harrison (Medical Research Council, Harwell, Berks, Eng.). Intern. J. Radiation Biol., 8: 177-86(1964).

Rats of two age-groups fed from weaning on a diet of constant composition were given a constant daily dose of ^{45}Ca and ^{85}Sr incorporated in the diet. In young rats (5 to 19 weeks old) increase of the calcium-intake from 0.56 to 1.1 g per cent decreased the skeletal retention of radioactive stronium by 45 per cent. In adults (16 to 26 weeks old) there was no change in the radioactive strontium deposited in bone when the calcium intake was doubled. The renal clearance of ^{85}Sr increased with age and was also higher in rats on the higher calcium-intake. The overall discrimination between strontium and calcium, diet to bone, was not only age dependent but also showed a marked change when the calcium-intake was doubled. (auth)

5614 THE EFFECT OF DTPA TREATMENT AFTER ADMINISTRATION TO RATS OF ^{239}Pu(VI) IN NITRIC ACID. Hylton Smith, T. H. Bates, B. Dymond, and I. V. Chapman (United Kingdom Atomic Energy Authority, Annan, Scotland). Intern. J. Radiation Biol., 8: 191-3(1964).

The body burden of ^{239}Pu(VI) in nitric acid was reduced in rats by the administration of diethylenetriaminepentacetic acid (DTPA). Data are presented on the distribution of ^{239}Pu when DTPA was administered at various intervals up to 43 days. (C.H.)

5615 UNSTABLE COMPLEXES OF ^{125}I-LABELED HOUSE DUST AND AN ANTIBODY-LIKE GLOBULIN FROM HUMAN SERUMS. Charles E. Reed (Univ. of Wisconsin, Madison). J. Allergy, 35: 274-85(May-June 1964).

Isolation and ^{125}I-labeling of a house dust allergen, and its use in an assay procedure using specific antibody, are described. (BBB)

5616 MOLECULAR WEIGHT OF HUMAN PITUITARY GONADOTROPINS AS DETERMINED BY RADIATION INACTIVATION OF BIOLOGICAL ACTIVITY. W. D. Odell (National Cancer Inst., Bethesda, Md.), R. W. Swain, and M. Nydick. J. Clin. Endocrinol. Metab., 24: 1266-70(Dec. 1964).

Purification is not required to determine the molecular weight of protein hormones by means of radiation inactivation. Acetone-dried human pituitary powder, a urinary preparation from human castrate males (NIH-HPG-UE), and a urinary preparation from postmenopausal human females (Pergonal) were radiated with 2.0 Mev electrons at varying doses. Loss of biological activity was measured by means of prostate and testes weight in hypophysectomized rats. When the loss of biological activity was plotted against radiation dose, exponential curves were obtained. These plots were identical for all 3 gonadotropin preparations and for each of the bioassays. Molecular weight estimates of the gonadotropins in all 3 preparations were similar and averaged 31.4×10^3 (range 30.0–34.0), irrespective of which bioassay was used. Using identical methods, previous studies on human chorionic gonadotropin have also resulted in molecular weight estimates of 30.4×10^3. It is concluded that human FSH, LH and chorionic gonadotropin have similar molecular weights of approximately 30,000. (auth)

5617 AN 18 YEAR STUDY OF THE USE OF BEEF THYROTROPIN TO INCREASE I^{131} UPTAKE IN METASTATIC THYROID CANCER. Richard S. Benua, Martin Sonenberg, Robert D. Leeper, and Rulon W. Rawson (Memorial Sloan-Kettering Cancer Center, New York). J. Nucl. Med., 5: 796-801(Oct. 1964).

Eighty-two courses of treatment with beef thyrotropin (TSH) were used in 48 patients to increase the collection of radioactive iodine in metastatic thyroid cancer. The usual regime was 10 units twice daily for 5 days. Highly significant increases in tumor uptake were noted in 5 to 32 studies in which pre and post-TSH data were available. In these 5 instances, uptake more than doubled, but the average increase was 59% for the 32 studies. This response could not be correlated with the dose of thyrotropin over the range employed or the histologic type of the tumor. Whole body retention of the radioactive iodine was 25% higher after TSH, but this change was not statistically significant. Allergic manifestations occurred in 2 of 18 patients receiving more than one course of injections. In no instance did the thyrotropin appear to stimulate tumor growth. Thyrotropin stimulation should be attempted when thyroidectomy and antithyroid agents fail to yield sufficient tumor uptake to permit therapy. (auth)

5618 STERNAL MARROW CIRCULATION BY THE RADIOISOTOPE CLEARANCE TECHNIQUE. Sidney Trubowitz, Herbert Strauss, and Maurice J. Small (Veterans Administration Hospital, East Orange, N. J.). J. Nucl. Med., 5: 864-70(Nov. 1964).

A re-evaluation study was made on the applicability of the tracer clearance technique to the study of bone marrow blood flow. The clearance rates of $^{22}NaCl$, ^{131}I human serum albumin, and ^{131}I Hippuran from marrow were determined. The disappearance rate of radioisotopes is rapid ($T\frac{1}{2}$ of 21–24 sec) and independent of molecular or ion size. Mobilization of ^{131}I Hippuran from marrow lagged slightly behind the clearance of this dye into the bladder following intravenous administration. The marrow appears to possess a unique organization for fluid flow. (P.C.H.)

5619 PHARMACOLOGY AND TOXICOLOGY OF LUTETIUM CHLORIDE. Thomas J. Haley, N. Komesu, M. Efros, L. Koste, and H. C. Upham (Univ. of California, Los Angeles). J. Pharm. Sci., 53: 1186-8(Oct. 1964). (TID-20446)

The pharmacological and toxicological properties of lutetium chloride were investigated in mice. The intraperitoneal and oral LD_{50}'s were 315 and 7.1 mg/kg, respectively. Studies of chronic toxicity showed no effect on growth and the hemogram or any internal organ changes at autopsy. Transient ocular irritation was observed, and the chemical produced extensive scar formation when applied to abraded skin. Nodules were formed at the site of intradermal injection. Pharmacological studies showed the chemical to be a depressant on all systems studied. Death resulted from cardiovascular collapse coupled with respiratory paralysis. Such effects could not be counteracted by atropinization or epinephrine injection. (auth)

5620 DISTRIBUTION OF COBALT-60 IN THE RAT AS INFLUENCED BY CHELATING AGENTS. Du Khuong Lê (Kernforschungszentrum, Karlsruhe, Ger.). Nature, 204: 696-7(Nov. 14, 1964).

Albino rats of the Heiligenberg strain (6-10 weeks old, 170-210 g) were intravenously injected with approximately 5 μC of carrier-free $^{60}CoCl_2$. To achieve maximum effectiveness, the different compounds were administered immediately after the injection of ^{60}Co. The dosage was 200 μmoles per animal, with the exception of the relatively toxic 2-mercapto-ethyliminodiacetic acid (MEIDA) (25 μmoles). The animals were killed 48 hr later, and the radioactivity of the organs assayed by means of a KI(Tl)-scintillation crystal. In good agreement with other investigations, ^{60}Co was eliminated rather quickly from the body, and the total retention after 48 hr amounted to 8-11%. The highest concentrations were observed in liver and kidneys. The superiority of diethylenetriaminepentaacetic acid (DTPA) over EDTA was confirmed. (P.C.H.)

5621 TROPHIC LEVEL EFFECT ON THE ACCUMULATION OF CESIUM-137 IN COUGARS FEEDING ON MULE DEER. R. C. Pendleton, R. D. Lloyd, C. W. Mays, and B. W. Church (Univ. of Utah, Salt Lake City). Nature, 204: 708-9(Nov. 14, 1964).

An examination of the accumulation of fallout nuclides in the tissues of mule deer was carried out. In the course of the work, a series of three cougars was taken within a period of 6 weeks. All the animals were taken in the field with firearms, and most of the deer were collected from the same areas as were the cougars. The average ^{137}Cs content for the deer was 504 pC/kg and the average for the cougars was 1,736 pC/kg. The results demonstrate a clear-cut increase of three-fold or better between the ^{137}Cs level in deer flesh and cougar flesh. Implications of a trophic level increase are demonstrated diagrammatically. (P.C.H.)

5622 THE RATE OF CONSUMPTION OF OXYGEN BY ANTHERS OF TRADESCANTIA PALUDOSA. L. H. Gray and G. M. Douglas (Mount Vernon Hospital, Northwood, Middlesex, Eng.). Radiation Botany, 4: 233-45(Nov. 1964).

The paper describes an adaptation of the Hersch technique for the micro-assay of oxygen which permits one to sample the oxygen content of the gas in a small enclosure containing some forty anthers, and thereby to evaluate the rate of consumption of oxygen by a known mass of anther tissue over a period of several hours and with varying partial pressures of oxygen in the moist chamber. The fall in the rate of consumption of oxygen with partial pressure in the gas phase is best accounted for by assuming that this reflects the limited extent to which the oxygen is able to penetrate the substance of the anther. Calculations

based on a simple diffusion model agree only qualitatively with the observations. In part this is due to the fact that, even when oxygen is not limiting, respiration declines with the time which has elapsed since the anther was dissected from the bud. Better quantitative agreement is obtained if it is assumed that the surface is much less permeable to oxygen than the bulk of the anther tissue. The oxygen consumed per unit mass was found to be greatest in the small anthers containing microspores in early interphase, falling as the microspores approached the end of interphase, and becoming least during mitosis. The respiration of early interphase anthers was slightly, but possibly not significantly, depressed by the addition of 5 per cent CO_2 to the gas phase. The mean respiration rate of anthers containing microspores in division was not measurably affected by 5 per cent CO_2. (auth)

5623 TRANSLOCATION OF STRONTIUM FROM LEAVES OF BEAN AND CORN PLANTS. John E. Ambler (Agricultural Research Service, Beltsville, Md.). Radiation Botany, 4: 259-65(Nov. 1964).

Translocation of ^{85}Sr from leaves of bean and corn plants to plant parts was measured at successive stages of growth. Translocation was greater from leaf applications that were periodically rewetted than from applications allowed to air dry and stay dry. The maximum amount of ^{85}Sr translocated from rewetted bean and corn leaves was about 0.6 and 0.5 per cent, respectively, of that applied. In bean plants the greatest translocation occurred from the youngest leaf (fourth trifoliate), treated 20 days after the straightening of the hypocotyl. In corn this occurred from the youngest leaf (leaf nearest the tassel) treated 10 days before pollination. Translocation of ^{85}Sr into roots and fruit parts, from rewetted applications, was less than 0.006 per cent of that applied. From most foliar treatments, allowed to air dry and stay dry, translocation was less than 0.01 per cent of that applied. (auth)

5624 THE INTERACTION OF YTTRIUM WITH PHYSIOLOGICAL LIGANDS. June Egawa, William F. Neuman, and Robert Gaunder (Univ. of Rochester, N. Y.). Radiation Res., 23: 503-13 (Dec. 1964).

To clarify the transport of Y in vivo, a variety of physiologically important ligands were studied for their ability to interact with Y at physiological pH. Because of the complexity of Y hydrolysis to ill-defined colloids, relatively simple techniques were employed. Nonetheless, it became clear that the principal variables affecting the solubility and diffusibility of yttrium are the presence or absence of phosphate, citrate, protein, and carrier yttrium. (auth)

5625 UPTAKE OF RADIOSULFUR (S^{35}) AT THE LEVEL OF THE LABYRINTHINE CAPSULE OF RATS AFTER TREATMENT WITH CORTICO-SUPRARENAL HORMONES: HYDROCORTISONE, ALDOSTERONE, DEHYDROISOANDROSTERONE. M. Presenti, G. Aliprandi, and A. Villa (Università, Milan). Radiobiol. Latina, 6: 317-38 (July-Sept. 1963). (In Italian)

The variations due to the action of cortisone, dehydroepiandrosterone, and aldosterone on the metabolism of ^{35}S in the tibia and in the labyrinthine capsule of the rat were studied. The results are given on the incorporation of ^{35}S as determined by external counter and the histoautoradiographic techniques. (auth)

5626 INCORPORATION OF RADIOACTIVE SULFUR (S^{35}) AT THE NASAL MUCOSA LEVEL OF RATS AND GUINEA PIGS IDENTIFIED BY HISTOAUTORADIOGRAPHIC TECHNIQUE. M. Pesenti and A. Villa (Università, Milan). Radiobiol. Latina, 6: 357-75(July-Sept. 1963). (In Italian)

Results are reported from investigations of the mucopolysaccharide metabolism of the nasal mucosa in rats and guinea-pigs with the aid of radioisotope techniques using ^{35}S as a tracer. (auth)

Radiation Effects

5627 (ABCC-62-63) ANNUAL REPORT, JULY 1, 1962–JUNE 30, 1963. (Atomic Bomb Casualty Commission, Hiroshima). Contract AT-49-1-GEN-72. 82p. Dep.(mn); $3.00(cy), 2(mn) OTS.

Results of comparative studies on Japanese adult health, pathology, and life span are reported. The life span studies are being conducted to compare experiences of individuals involved in bomb explosions with those not in the bombed cities. The adult health studies are aimed at determining the effects of therapy on exposed persons and at determining the effects of low-dose exposures. The pathology studies are directed toward diagnosis of radioinduced disease. Studies on morbidity, genetics, specific diseases or disorders, fertility, pediatrics, and dosimetry are described. Administrative information is also included along with lists of technical reports issued during 1962-63. (J.R.D.)

5628 (TID-3579) INSECT CONTROL BY RADIATION AND RADIOISOTOPES. Helen L. Ward, comp. (Division of Technical Information Extension, AEC). Nov. 1964. 32p. Dep.; $2.00(OTS).

One hundred and one selected references are presented on the uses of radiation and radioisotopes in entomology. These references were selected from the scientific literature published since 1961. An index to the insects studied is included. (auth)

5629 (TID-21392) EXPERIMENTAL RADIATION CATARACT. A STUDY OF THE IRRADIATED HALF-SHIELDED RAT LENS (thesis). Herbert D. Fenske (Iowa State Univ., Iowa City). June 1964. Contract AT(11-1)-1024. 85p. (AD-441045). Dep.(mn); $3.00(cy), 2(mn) OTS.

Biochemical changes and x ray induced cataracts were studied in the crystalline lens of rats following exposure of the whole or half-shielded lens. Data are included on the dose response of the lens, and radiation effects on the whole and half-shielded rat lens, eyelids, and cornea following fractionated or single radiation exposure. 91 references. (C.H.)

5630 (UCD-34P80-2) RADIATION TECHNOLOGY IN CONJUNCTION WITH POSTHARVEST PROCEDURES AS A MEANS OF EXTENDING THE SHELF LIFE OF FRUITS AND VEGETABLES. Annual Report, February 1, 1963–January 30, 1964. E. C. Maxie, N. F. Sommer, and D. S. Brown (California. Univ., Davis). Contract AT(11-1)-34. Dep.; $5.00(cy), 3(mn) OTS.

Progress is reported in the evaluation of radiation processing as a potential supplement to cold storage and other technical procedures in increasing the storage life of fresh fruits and vegetables. Data are presented on the effects of various doses of γ radiation on the texture, nutritional qualities, odor and flavor, appearance, and susceptibility of decay-producing bacteria and fungi of cherries, lemons, Bartlett pears, strawberries, grapes, peaches, nectarines, and tomatoes. It was concluded that radiation processing reduces the amount of decayed fruit during a normal marketing sequence, although irradiation will intensify inherent physiological disorders in fruits. (C.H.)

5631 (ANL-Trans-111) THE RELATIVE BIOLOGICAL EFFECTIVENESS IN MEDICAL RADIOLOGY. THE RELATIVE BIOLOGICAL EFFECTIVENESS OF IONIZING RADIATION (RBE). O. Hug. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Biophysik, 1: 210-13(1964). 5p. Dep.(mn); $1.10(fs), $0.80(mf) JCL.

When the concept of RBE was introduced into radiation protection, it was done with the purpose of deriving the maximum permissible doses of dense ionizing radiation from those of x rays of medium hardness and from γ rays and of expressing additively the total effective radiation load of an individual or else the risk connected with it. Hence, a revision of the RBE-values based on simplified assumptions and eventually also of the RBE concept became more and more urgent. In view of this the International Commission for radiation therapy organized in 1960 a special RBE committee which has been working for three years under the direction of L. F. Lamerton. The principles of the radiation effect on which the different effects

of different types of radiation and their properties are based are summarized. Practical conclusions for radiation protection are discussed. (auth)

5632 (ANL-Trans-114) THE RELATIVE BIOLOGICAL EFFECTIVENESS OF 15-Mev ELECTRONS AND 200-kv X RAYS UPON THE ROOT POINT CELLS OF ALLIUM CEPA. W. Friedrich and B. Markus. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Biophysik, 1: 216-17(1964). 3p. Dep.(mn); $1.10(fs), $0.80(mf) JCL.

Results are reported from studies of the relative biological effects of 15-Mev electrons and 200-kv x radiation. The mitosis frequency and distribution of mitosis phases and chromosome changes induced in root cells of Allium were used as criteria of radiation effects. (C.H.)

5633 CHANGES IN THYROID AND LIVER IN GUINEA PIGS AFTER ADMINISTRATION OF ^{131}IODINE. P. Georgi, N. Hartmann, and H. -J. Henschel (Ernst-Moritz-Arndt Universität, Greifswald, Ger.). Acta Biol. Med. Ger., 11: 881-8(1963). (In German)

Concentrations of iodine, monoiodotyrogine, diiodotyrosine, thyroxine, and an unidentified thyroid metabolite were measured in thyroid gland hydrolysates from guinea pigs after subcutaneous injection of inorganic ^{131}I. After 20 hr, 30 or 40% of the ^{131}I was found in both of the iodinated amino acids regardless of whether 100 or 400 μC was given initially, or when 100 μC was given 20 hr prior to sacrifice, 32 days after original injection of 400 μC. Thyroxine-^{131}I was increased in the animals killed after 32 days. It was also increased in animals that had received daily injections of 0.5 μC of ^{131}I for from 100 to 120 days. The results suggested an increase in the enzymatic synthetic activity of the thyroid. In order to study possible effects of ^{131}I on deiodination activity of liver and kidneys, guinea pigs were injected with 200 and 400 μC and killed after 90 days. There was a statistically significant decrease in the liver deiodase, independent of the dose given, but none was observed in kidneys. No significant differences were observed when smaller doses of ^{131}I were given daily. The deiodinating activity of liver was reduced in one week old guinea pigs after a single injection of 400 μC given 90 days before the animals were killed. The reduction of enzymatic activity was less than that observed in adult animals, suggesting a greater regenerative capacity in the livers of the younger animals. This injection had no effect on the deiodinating capacity of kidneys. (BBB)

5634 EXPERIMENTAL AND CLINICAL STUDIES ON AN ANTI-TUMOR ACTIVITY OF OX SUBSTANCE. Tadashi Ofuji. Acta Med. Okayama, 18: 55-64(Apr. 1964).

The anti-tumor influence of unsaturated fatty acids extracted from livers of irradiated rabbits (OX substance) was studied: on cell suspension cultures of Yoshida sarcoma cells, of celothelioma cells, and of Ehrlich ascites tumor cells; in three cancer patients; and on mouse leukemia. OX substance showed marked cytotoxicities in cell suspension culture of Yoshida sarcoma cells, celothelioma cells, and Ehrlich ascites tumor cells. OX substance was effective by its contact action on patients with peritonitis carcinomatosa, celothelioma and rectal carcinoma. Esterified OX substance was injected intravenously or intraperitoneally into CBA mice with ascites leukemia. The substance prolonged their life span and inhibited the progression of leukemia. (H.M.G.)

5635 STUDY OF SWINE SURVIVING EXPOSURE TO THE GAMMA-NEUTRON FLUX OF A NUCLEAR DETONATION. James N. Shively, Albert R. Warner, Jr., Harold P. Miller, Harold J. Kurtz, Howard L. Andrews, and Kent T. Woodward (Walter Reed Army Inst. of Research, Washington, D. C. and National Cancer Inst., Bethesda, Md.). Am. J. Vet. Res., 25: 1341-6(Sept. 1964).

Swine surviving midlethal irradiation with the gamma-neutron flux of a nuclear detonation and swine surviving about ½ $LD_{50/30}$ gamma-neutron irradiation plus midlethal x-irradiation 4 months later did not experience undue morbidity or mortality during a 2-year observation period. Circulating leukocytes returned to normal levels within less than a year after midlethal irradiation. The reirradiated swine had significantly depressed leukocyte levels throughout a 20-month observation period. It was not possible to attribute the deficiency to any particular cell type. Both the midlethally irradiated and the reirradiated swine gained significantly less weight than did control swine. Contribution of the 2nd exposure could not be evaluated. Failure to demonstrate changes in the number and viability of progeny indicates that swine surviving brief radiation exposures are capable of reproducing efficiently when bred 8 months or longer after irradiation. (auth)

5636 CHEMICAL SENSITIZATION OF CLOSTRIDIUM BOTULINUM SPORES TO RADIATION IN MEAT. K. L. Krabbenhoft, D. A. Corlett, Jr., A. W. Anderson, and P. R. Elliker (Oregon State Univ., Corvallis). Appl. Microbiol., 12: 424-7(Sept. 1964).

The effect of common chemical additives was studied in relation to the dose of γ radiation required to destroy C. botulinum spores inoculated into canned ground round steak. Spores of type 33-A were used since it is one of the most radiation-resistant forms. The spores were inactivated in samples (irradiated at 2.0, 2.5, and 3.0 Mrad) which contained sodium nitrate (1000 ppM) plus sodium chloride (2.5%). Similar results were obtained when sodium nitrite (200 ppM) was substituted for sodium nitrate. Spore destruction was based upon the absence of spores and mouse-lethal toxin in meat subcultures made from cans incubated at 35°C for 120 days. Spores were not destroyed when exposed to 2.5 or 3.0 Mrad in the absence of sodium nitrate, sodium nitrite, or sodium chloride. Furthermore, the use of these chemicals individually, together with radiation, was ineffective. The additives alone in the absence of radiation also did not cause spore destruction. Radiation levels of 2.0, 2.5, and 3.0 Mrad, when used with sodium chloride at 1.5 or 2.0% and sodium nitrate at 500 ppM or sodium nitrite at 100 ppM, were ineffective. The observation that combinations of either sodium nitrate or sodium nitrite with sodium chloride lower the dose of radiation necessary to destroy C. botulinum offers the possibility of the use of these additives in radiation-preserved foods. (BBB)

5637 MORPHOLOGIC CHANGES INDUCED BY X-RAYS IN THE NERVE CELLS OF THE SYMPATHETIC GANGLIA IN RABBITS. Józef Tarmas, Stanisław Kośmider, and Zdzisław Rusiecki (Silesian School of Medicine, Zabrze, Poland). Arch. Immunol. Therapi. Exptl., 12: 388-95(1964).

In rabbits subjected to whole-body irradiation with single doses of 300, 500, 700, or 1000 R of x rays, morphologic changes proportional to the magnitude of the dosage appeared in the ganglionic nerve cells of the sympathetic trunk. Single doses of 700 or 1000 R of x radiation produced more profound and more frequent damage of the cell structure, ranging from degenerative to colliquative necrotic lesions and coagulation, resulting in irreversible damage of some of the ganglionic nerve cells. After single doses of 700 R the morphologic alterations in the glanglionic cells of the sympathetic trunk increased not only in proportion to the magnitude of dosage but also to the time elapsing after irradiation. It was concluded that x rays in single doses of 300, 500, 700, or 1000 R induce polyneuronic damage of cell structure in the autonomic nervous system. (auth)

5638 EFFECTS OF X RAYS ON BILIARY BILIVERDIN AND STERCOBILIN. G. Barac and Marie-Louise Beaumariage (Université, Liège). Arch. Intern. Physiol. Biochem., 72: 514-15(June 1964). (In French)

It was previously shown that irradiation of pure bilirubin and biliverdin in aerated aqueous solution destroyed these pigments, giving rise to propendiopent. The effect of x rays has now been studied on biliary biliverdin, which is essentially a mixture of the mono- and diglucuronides of pure biliverdin, and also on stercobilin which possesses an interpyrrolic b methene group, a site of the possible scission of the molecule. Irradiation with soft x rays was carried out. Fresh chicken bile was diluted with water, passed through an ion-exchange column, then distilled over $KMnO_4$. Both biliverdin and stercobilin were determined by direct

photometry. Results showed that biliary biliverdin solutions are discolored by x rays, as is the pure pigment, and propendiopent formed. The same process occurred in the case of stercobilin, the x ray effect being greater in 0.01N NaOH than at pH 7.4. The decoloration of the irradiated stercobilin was not due to the formation of stercobilinogen but to that of propendiopent which is transformed into pendiopent. Pendiopent has a characteristic absorption peak in the visible range and marked sensitivity to atmospheric oxygen. Ascorbic acid was found to act as an antioxidant, protecting stercobilin against x-ray-induced transformation. (BBB)

5639 PRELIMINARY RESULTS ON THE STUDY OF THE INTESTINAL ABSORPTION OF VITAMIN B_{12} MARKED WITH ^{58}Co IN PATIENTS IRRADIATED IN THE ABDOMINAL PELVIC REGION. L. Dalla Palma and L. Cionini (Universita, Florence). Atti. Congr. Soc. Ital. Gastroenterol., 15: 103-10(Nov. 1963).

A study was made of the changes induced by irradiation on the intestinal absorption of vitamin B_{12} in 14 patients submitted to telecobaltotherapy and telecobaltotherapy associated with radium. The subjects fasted during the night before each irradiation session and received an oral dose of one μg of cyanocobalamin labelled with ^{58}Co (sp act. 0.5 C/g), and continued fasting during the next three hr. They also received two intramuscular injections of cyanocobalamin (1000 μg) three and 24 hr after the oral dose. An evaluation was made on one group before, during, and after the irradiation, and on another, only before and after. Samples of stools were taken until the measurable radioactivity disappeared, and the results were based on the total dose absorbed, as calculated by the amount retained. The average pretherapy retention was 60.21%, but analysis of the individual cases showed that in 10 subjects out of 14 the absorption exceeded 60%. The percentage of absorption decreased to 30 to 40% during the course of the radiotherapy (after accumulated doses of ~ 2500 R) and increased again toward the end of treatment to ~ 50%. The recovery of the absorption capacity for vitamin B_{12} was attributed to the return of the gastrointestinal mucosa to its normal functional state. Some variability was noted in the responses of the patients which was more evident in the cases that received radium and telecobalt irradiation. (BBB)

5640 TRANSFER OF THE ESCHERICHIA COLI K12 CHROMOSOME IN THE ABSENCE OF DNA SYNTHESIS. Joan C. Suit, Thomas S. Matney, C. O. Doudney, and Daniel Billen (Univ. of Texas, Houston). Biochem. Biophys. Res. Commun., 17: 237-41(Oct. 14, 1964).

Evidence is reported showing that normal chromosome transfer in one E. coli K12 Hfr strain occurs without concomitant DNA synthesis. (auth)

5641 FERROCHELATASE ACTIVITY IN SOME ORGANS OF LETHALLY IRRADIATED RABBITS. A. Mazanowska and A. M. Dancewicz (Inst. of Nuclear Research, Warsaw). Bull. Acad. Polon. Sci., Ser. Sci. Biol., 12: 293-6(1964).

The activity of ferrochelatase was determined in homogenates of heart, liver, spleen, and bone marrow of rabbits irradiated with a 1000 R x radiation. Irradiated animals were killed by bleeding from the heart at 5 to 15 min. after exposure or on the 1st, 2nd, or 3rd day after irradiation. The organs were removed and immediately used for preparation of homogenates and enzyme assays. The activity of ferrochelatase was assayed by a method based on the measurement of the rate of incorporation of ^{59}Fe into protoporphyrin in the presence of tissue homogenate. Systems without homogenate were used as controls. The results were expressed as the fraction of ^{59}Fe incorporated into protoporphyrin calculated per 1 g. of fresh tissue or per 1 mg. of protein nitrogen. (auth)

5642 INFLUENCE OF SUBLETHAL IRRADIATION (400 r) ON THE ACQUIRED IMMUNITY OF MICE AGAINST HOMOTRANSPLANTABLE EHRLICH TUMOR. H. Bazin and J. F. Duplan (Institut du Radium, Paris). Bull. Assoc. France. Etude Cancer, 50: 579-92(Oct.-Dec. 1963). (In French)

The effect was studied of a single dose of 400 R of x rays on the acquired immunity against Ehrlich tumor in mice receiving no therapy, and in those restored by isogenic hemopoietic cells originating either from previously immunized or nonimmunized animals. Results showed a decrease in acquired immunity, which appeared to be limited to homografted tumors and dependent on the time lapse between irradiation and tumor cell transplantation. It is probable that the extended disappearance of the acquired immunity is due to the loss of immunological memory rather than a disturbance in immunological capacity. Restoration by means of isologous spleen cells appeared to accelerate recovery of acquired immunity (spleen cells were much more effective than bone marrow cells in this respect). This influence could be due to a general salutary effect of restoration on the whole body of the irradiated animal and to the strengthening of the secondary response brought about by a primary response of the immunologically competent grafted cells. Restoration in irradiated animals by means of cells originating from previously immunized animals transfer immunity which is added to that previously acquired. It is also possible to transfer a low degree of antitumor cell immunity by the injection of bone marrow cells derived from immune donors. This confirms the presence of immunologically competent cells in the bone marrow of immunized mice, but due to their reduced number there is only a slowing of tumor growth rather than a rejection of the graft. (BBB)

5643 THE INFLUENCE OF NOVOCAINE ON IMMUNOGENESIS. N. N. Klemparaskaya. Bull. Exptl. Biol. Med. (USSR) (English Transl.), 56: 1124-7(Oct. 1963). Translated from Byul. Eksperim. Biol. i Med., 56: 77-81(Oct. 1963).

Experiments were carried out on 33 rabbits and 570 mice. It was shown that novocaine injected subcutaneously or given by mouth daily depressed the production of agglutinins, hemolysins, and precipitins. The depression of antibody production was most marked and prolonged when the novocaine was given by subcutaneous injection; it then persisted after the treatment had been discontinued. When the novocaine was given by mouth antibody production was depressed only during the period of treatment; in some animals the antibodies were formed after the end of the treatment. In mice immunity to typhoid bacillus was depressed after subcutaneous administration of novocaine. After mice had been irradiated with 300 R, immunogenesis was depressed whichever way the novocaine was given. The results obtained may be important in relation to the depression of the immune response in treatment of radiation sickness, in tissue transplantation, and in tumor development. (auth)

5644 EFFECTS OF X RAYS ON RHIZOGENESIS PHENOMENA OF THE HYPOCOTYLS OF LUPINE CULTIVATED IN VITRO. Shankar Narayanaswamy. Compt. Rend., 259: 2513-16(Oct. 12, 1964). (In French)

If hypocotyls of white lupines cultivated in vitro are treated with x rays, a decrease or an augmentation of the number of newly formed roots occurs according to the dose and the moment of irradiation. The structure of the roots is disturbed as a result of an inhibition of the generating zones and an alteration of the differentiation of the xylene and phloem. (tr-auth)

5645 RADIATION INDUCED CONGENITAL DEFECTS IN ALBINO RATS. H. J. Arnikar, L. M. Singh, and K. N. Udupa (Banaras Univ., India). Current Sci. (India), 32: 209(May 1963).

During the course of a study on the rate of healing of bone fractures in albino rats, two series of experiments were conducted employing radioactive isotopes, ^{35}S and ^{32}P, for intraperitoneal injection at different stages of the healing. One of the rats which had received an injection of 50 mC of ^{32}P in the form of carrier-free sodium hydrogen phosphate buffer at pH of 5.6 was pregnant and its scheduled sacrifice was therefore abandoned. She gave birth to

four baby rats in normal time after two weeks. All these baby rats were found to be genetically deformed, two with three legs, one missing the hind and the other the fore leg, and two with very short tails. They are otherwise normal and living. Further study on this subject is in progress. (BBB)

5646 MULTIPLE ALLELISM IN RADIATION-INDUCED RAY-FLORET MUTANTS OF ANNUAL CHRYSANTHEMUM. R. S. Rana (Indian Agricultural Research Inst., New Delhi). Current Sci. (India), 33: 592-3(Oct. 5, 1964).

An investigation was designed to induce variation in Chrysanthemum carinatum flowers by using acute doses of x radiation. Four mutant types affecting the ray-florets were obtained in the X_2 population. Further recombination tests revealed that all the four mutants differed from the normal type as well as from one another with respect to a single gene and that all of them were recessive in inheritance to the normal phenotype. Results are explained in terms of multiple allelism at a single gene locus. (H.M.G.)

5647 ANALYSIS OF THE VIRUS-PRODUCING INTERACTION OF RAT ROUS SARCOMAS (XC AND MR_s) WITH THE FOWL CELL. P. Chyle (Inst. of Experimental Biology and Genetics, Prague). Folia Biol. (Prague), 10: 359-65 (1964).

In experiments designed to induce infectious virus formation in rat Rous sarcomas XC and MR_s, it was found that even small doses of x rays lower the incidence of induced tumors in test-chicks. Apart from direct cell to cell contact it was demonstrated that it is essential for both cell types taking part in the virus-producing interaction, to be fully viable under conditions of in vivo cultivation in diffusion chambers implanted into the peritoneal cavity of the homologous fowl host just as in in vivo and in vitro experiments. The details of the mechanism of this interaction are not yet clear. (auth)

5648 NOTE ON THE DIFFERENTIATION OF COLONIES OF HAEMATOPOIETIC TISSUE CELLS IN THE SPLEEN OF IRRADIATED MICE. Věra Jurášková, L. Tkadleček, and V. Drášil (Inst. of Biophysics, Brno and Military Inst., Hradec Kralove, Czechoslovakia). Folia Biol. (Prague), 10: 381-5(1964).

In the spleens of irradiated mice, transplanted syngenic bone marrow cells form colonies, which are usually composed of cells of the same hematopoietic series (erythroid, myeloid or megakaryocytic). Smears of suspensions of cells from these colonies most frequently contained erythroid type colonies (62%) and less often myeloid (17%) and mixed (21%) colonies. Histological examination gave similar results; erythroid 45%, myeloid 14%, mixed 23% and 18% small nodules composed of megakaryocytes. In the discussion these results are compared with the findings of other authors, and the significance of the study of colonies of hematopoietic cells when resolving hematological and radiobiological questions is stressed. (auth)

5649 MECHANISM OF RAISED RESISTANCE OF RATS TO HYPOXIA IN ACUTE RADIATION INJURY. D. A. Chetverikov, Svyetlana V. Gasteva, K. P. Ivanov, A. Vacek, and M. Pospíšil (Pavlov Inst. of Physiology, Leningrad and Inst. of Biophysics, Brno). Folia Biol. (Prague), 10: 386-91(1964).

In rats subjected to whole body irradiation, raised resistance to hypoxia was observed at most of the postirradiation intervals studied up to 96 hours. The maximum effect, found 72 hours after irradiation, is evidently related to a decrease in the metabolic rate, accompanied by lowering of the body temperature and of total oxygen consumption, which is especially pronounced during hypoxia in this phase. The basic factor in metabolic changes in the irradiated animals in this phase was found to be disturbance of regulatory functions. The results showed that the participation of other nonspecific resistance mechanisms can also be presumed, particularly at the early postirradiation intervals. (auth)

5650 THE EFFECTS OF X-RAYS ON QUANTITATIVE CHARACTERS. G. A. Clayton and Alan Robertson (Inst. of Animal Genetics, Edinburgh, Scotland). Genet. Res., 5: 410-22(Nov. 1964).

The rate of production by x rays of new genetic variation in two quantitative characters in Drosophila melanogaster (sternital and sternopleural bristles) was investigated, using plateaued populations which had reached the limit under artificial selection and, for sternital bristles only, populations which were made genetically invariant by inbreeding. The genetic variation was always measured by the response of the population to selection. The x-ray dose given in any generation was always 1800 R to adults. Seven plateaued lines had eight cycles of alternate irradiation and selection, each with its non-irradiated control. All the responses were small but in three lines they were significantly greater after irradiation. Selection was applied to three different inbred lines, genetically marked to detect contamination, after varying periods of irradiation. At the same time, the inbred lines and lines derived from them which had been mass mated in bottles were selected. The irradiated populations showed a greater response. The new genetic variance produced by the irradiation was approximately 10^{-5} units/R. The estimate of the dose required to introduce new variation equal to that in a standard outbred population was 500,000 R. The effective population size was an important factor in the interpretation of some of these results on the long-term effects of radiation. By observing the variation between replicate lines in the frequency of a gene with a visible effect under these culture conditions (i.e. in a single culture bottle) the effective population size was estimated at sixty. Outbred populations kept under these conditions for many generations showed a reduction of genetic variability in agreement with this value. To investigate the possibility that the deleterious genes produced by irradiation would interfere with the response to artificial selection, a standard outbred population was irradiated and selected. In spite of the observed high frequency of recessive lethals produced, the response to selection was very similar to that of the standard population. (auth)

5651 THE OVERALL RATES OF DOMINANT AND RECESSIVE LETHAL AND VISIBLE MUTATION INDUCED BY SPERMATOGONIAL X-IRRADIATION OF MICE. Mary F. Lyon, Rita J. S. Phillips, and A. G. Searle (Medical Research Council, Harwell, Berks, Eng.). Genet. Res., 5: 448-67(Nov. 1964).

Hybrid (C3H♀ × 101♂) male mice were given two doses of 600 R acute x irradiation eight weeks apart and outcrossed at the end of their sterile period. Their fully fertile sons were outcrossed and daughters of these sons were backcrossed to them, in order to study the rates of induction in spermatogonia of dominant and recessive lethal and visible mutations, as well as dominant semi-sterility. F_1 litter-size decreased by 15.2% at birth and 15.8% at weaning age, as compared with controls. This decrease was very largely due to dominant lethality acting at about the time of embryonic implantation. There was also a highly significant increase in the incidence of heritable semi-sterility, the estimated rate of induction of reciprocal translocations being 3.3% per gamete. The dominant lethality was shown to be partly a secondary consequence of induced translocation heterozygosis. The estimated overall rate of dominant lethal induction was 10.6% per gamete, with primary dominant lethals induced at a rate of 4.0% per gamete. The estimated mutation rate to dominant visible mutations was 4.6×10^{-7}/gamete/R, but this was based on only two mutations in the irradiated series. In the backcross generation there was again significantly more embryonic death in the irradiated series, mainly at the small mole stage and this was attributed to induced lethal mutation. The survival in the irradiated series was 96.80% of that in the controls and from this the rate of induction of recessive lethals was calculated to be 2.5×10^{-4}/gamete/R. There was no evidence of the induction of lethals acting later than 14 days' gestation. The estimated rate of induction of recessive visible mutations was 1.8×10^{-5}/gamete/R, but the results showed heterogeneity, probably due to personal factors. No significant sex-ratio differences were found. The results

were compared with those of specific locus and other relevant experiments. The rates of induction of recessive lethal mutations and of recessive visibles were both lower than might have been expected. On these results the mouse was only 4 to 5 times more sensitive than Drosophila to the mutagenic effects of radiation. (auth)

5652 THE EFFECT OF DOSE-RATE ON THE YIELD OF TRANSLOCATIONS AND DOMINANT LETHALS FOLLOWING SPERMATOGONIAL IRRADIATION OF MICE. R. J. S. Phillips and A. G. Searle (Medical Research Council, Harwell, Berks, Eng.). Genet. Res., 5: 468-72 (Nov. 1964).

F_1 (C3♀ × 101♂) male mice were given 1200 R ^{60}Co γ irradiation over twelve weeks and mated twelve weeks after the end of irradiation. The incidences of fetal and neonatal lethality and of semi-sterility in their offspring were compared with those in controls. Embryonic survival to 15 days in the irradiated series was 98.2% that of controls, while the incidence of semi-sterility was 0.9% compared with nil in the controls. Neither of these differences is significant. Comparison of these results with the significant rates of induction of dominant lethals and translocations in a previous experiment, in which a dose of 1200 R acute x irradiation was given to males of the same hybrid stock, show the existence of a dose-rate effect. Its magnitude cannot at present be accurately estimated. The reasons for this effect are discussed. It is concluded that the main cause of the lowered translocation yield is that restitution of breaks will be favored at low dose-rates, with less opportunity for the formation of interchanges. This could partly account for the lowered rate of induction of dominant lethals as well, but a full explanation is not yet possible. (auth)

5653 PHENOTYPIC VARIABILITY OF AN INDUCED MUTANT OF ANNUAL CHRYSANTHEMUM. R. S. Rana (Indian Agricultural Research Inst., New Delhi). Genetica, 35: 236-40(1964).

Variable expressivity of a mutant gene determining tubular flower form in annual chrysanthemum results in phenotypic variation approaching a continuous pattern. The analysis shows that this variability is primarily conditioned by variable genotypic background of the individual plants although environmental factors are also involved. It is suggested that regulation of phenotypic expressivity of qualitative genetic potentialities can lead to a pattern of continuous variation characteristic of the quantitative traits. (auth)

5654 THE STATE OF THE PERIPHERAL BLOOD AND THE BONE MARROW HEMOPOIESIS DURING THE CHRONIC INTRODUCTION OF CALCIUM^{45} INTO THE ANIMAL'S BODY. V. I. Ternov. Gigiena i Sanit., No. 9, 38-43(Sept. 1964). (In Russian)

The state of the hemopoietic system was studied in albino rats under conditions of long-term introduction into the gastrointestinal tract of the isotope in doses 10, 100, and 1000 times higher than the maximum permissible concentration (0.0009 to 0.09 μC/kg). It was found that it is already in three months that a dose exceeding 1000 times the maximum permissible concentration (0.09 μC/kg) causes a chronic radiation affection of the hemopoietic system. The isotope in a dose 100 times greater than the maximum permissible concentration (0.009 μC/kg) when administered for a period of $10\frac{1}{2}$ months, produced unstable shifts in certain indices of the peripheral blood and bone marrow hemopoiesis without any marked signs of radiation disease. The administration of ^{45}Ca in a dose exceeding 10 times the maximum permissible concentration (0.0009 μC/kg) for a period of 9 months produced no changes in the hemopoietic system. (auth)

5655 RESEARCH ON INDICATORS OF RADIATION DAMAGE. Harry D. Bruner (Atomic Energy Commission, Washington, D. C.). Ind. Med. Surg., 33: 495(July 1964).

Observations are briefly summarized regarding the effects of irradiation on cell and organ systems. These effects were examined from the standpoint of their possible use as indicators of chronic radiation damage. The modifying action of dose rate, kind of radiation, and fractionation on these possible end points were evaluated. The general observation was made that there are probably no indicators pathognomonic of irradiation and few residual tissue changes which will reliably indicate the level of prior irradiation. (BBB)

5656 RECONSTITUTION OF SOLUBLE COLLAGEN BY IRRADIATION. J. Kotek (Central Research Inst. of Food Industry, Prague), Z. Deyl, J. Rosmus, and M. Krajicek. Intern. J. Appl. Radiation Isotopes, 15: 551-3 (Sept. 1964).

It is shown that small doses of radiation bring about the aggregation of tropocollagen molecules into a more ordered fibrillar structure rather than a destruction of the helical arrangement. The irradiation was carried out using a ^{60}Co source with an intensity of 267244 r/hr. This procedure resulted in the separation of a rigid opaque gel. The time course of the reconstitution was shorter and the resulting structure more rigid, depending on the amount of fibrils present in the solution before reconstruction. (M.C.G.)

5657 CHROMATID ABERRATIONS IN TRADESCANTIA POLLEN TUBES INDUCED BY MONOCHROMATIC X-RAYS OF QUANTUM ENERGY 3 AND 1.5 kev. G. J. Neary, J. R. K. Savage, and H. J. Evans (Medical Research Council, Harwell, Berks, Eng.). Intern. J. Radiation Biol., 8: 1-19 (1964).

Mature pollen of Tradescantia paludosa and T. bracteata was irradiated with monochromatic x rays of quantum energy 3 kev and 1.5 kev. Chromatid aberrations were scored at metaphase of the pollen-tube mitosis (second postmeiotic mitosis). It was found that 1.5 kev x rays are efficient in producing aberrations; the yield of aberrations with 3 kev x rays is linearly proportional to dose; the oxygen dose-modification factor with 3 kev x rays is about 3 for true aberrations and 1.8 for single gaps. It is concluded that there is no longer any basis for the estimate that some 17 ionizations are required for efficient breakage of a chromatid. Instead, most of the facts are explicable in terms of breakage by a single energy-loss event in a microstructure of a chromatid, for example, a short length of a single macromolecule of DNA. (auth)

5658 MICROSCOPIC STUDY OF RADIOLESIONS TO THE HAIR SYSTEM IN THE CASE OF A MOUSE EXPOSED TO X-RAYS. M. L. Beaumariage (Université, Liège). Intern. J. Radiation Biol., 8: 45-50(1964). (In French)

At the age of eight days, C_{57} black strain mice have a hair coat in anagen stage. X irradiation with 550 R induces dysplasia and loss of hair. The epilation is temporary, and the hair is growing normally during the second cycle. The cyclic changes in the hair follicles explain the variations of radiosensitivity and consequently the localization of the epilation when irradiation is performed in the 5th and 15th day of age. (auth)

5659 ACID-DEOXYRIBONUCLEASE ACTIVITY AND LABILIZATION OF DEOXYRIBONUCLEIC ACID FROM NUCLEOPROTEIN IN THYMUS AND REGENERATING LIVER AFTER WHOLE-BODY IRRADIATION. R. Goutier, M. Goutier-Pirotte, and A. Raffi (Centre d'Etude de Energie Nucléaire, Mol, Belg.). Intern. J. Radiation Biol., 8: 51-8 (1964).

Free and specific activities of acid DNAase were measured in the thymus and regenerating liver of rats after 700 R whole-body x irradiation. Labilization of DNA has been evaluated in the same organs by the amount of DNA extracted in solution of increasing concentrations of sodium trichloracetate. The increase in DNAase specific activity observed in irradiated thymus is associated with increasing lability of the DNA-protein bonds. In normal regenerating liver, the specific activity of acid DNAase also increases, and this rise of enzyme activity is paralleled by an increased labilization of DNA. Irradiation of regenerating liver does not result in a further increase of acid DNAase specific activity, nor in a greater lability of DNA. Possible correlations between these changes and the cytological alterations after irradiation are discussed. (auth)

5660 THE GROWTH OF MURINE LYMPHOMATOUS TUMOUR-CELLS AS DETERMINED BY HOST SURVIVAL-TIME. Yosh Maruyama and Byron Wm. Brown, Jr. (Stanford Univ., Calif.). Intern. J. Radiation Biol., 8: 59-73 (1964).

A cell-dose–survival-time method of study was developed for the LSA ascites lymphoma of C57Bl/Ka mice for the intraperitoneal and intravenous inoculation of tumor-cells. A growth-model using survival-time as end point was experimentally studied. The generation time, as determined indirectly by survival-time, conforms with estimates of this parameter by direct means and suggests that murine lymphomatous tumor-cells grow exponentially during much of their growth in vivo under a given set of conditions. The mean rate of tumor-cell growth may differ according to site of growth. Death apparently occurs at a critical tumor-cell number in the range of inocula studied. Methods are described for the handling of the experimental data, for the estimation of the generation time, for the threshold number of tumor-cells which, when present in the host, may result in its death. Whole-body x irradiation given after the inoculation of the tumor-cells will prolong the survival-time by predictable periods of time. (auth)

5661 NUCLEOPROTEIN CHANGES IN REGENERATING LIVER NUCLEI AFTER X-IRRADIATION. Shirley Lehnert and S. Okada (Univ. of Rochester, N. Y.). Intern. J. Radiation Biol., 8: 75-83(1964).

Whole-body irradiation at doses of 800 R was given to rats 24 hours after partial hepatectomy, and two aspects of the response of the liver nuclei were studied in the 24 to 48 hours after hepatectomy. The in vivo incorporation-rate of DNA and protein precursors, and the absolute amount of protein and DNA in the nucleus at various times after hepatectomy and irradiation were determined. Incorporation of tritiated thymidine into liver DNA was found to be significantly inhibited during the whole period in irradiated animals. Incorporation of ^{14}C-lysine into acid-insoluble protein of liver nuclei was similarly inhibited during most of this period. In contrast there was apparently no inhibition of incorporation of ^{14}C-lysine into histone after irradiation. Following the first wave of cell-division which occurs in regenerating liver at about 28 hours after partial hepatectomy, all three components of the nucleus approximately double in amount before the next cell-division. After irradiation, however, this increase does not occur for the DNA and acid-insoluble protein components. The amount of histone however, increases in the nucleus to the same extent after irradiation as it does in the liver nuclei of nonirradiated animals. The net result of these processes is that the amount of protein, particularly histone, relative to DNA in the nucleus is increased after irradiation with the result that the composition of the irradiated nucleus differs markedly from that of the nonirradiated. (auth)

5662 FRACTIONATED DOSES OF X-RADIATION: A PRELIMINARY STUDY OF EFFECTS ON TELEOST EMBRYOS. John C. White, Jr. (Bureau of Commercial Fisheries, Beaufort, N. C.). Intern. J. Radiation Biol., 8: 85-91 (1964).

Doses of x radiation, fractionated during the first six days of embryogenesis, produced a delay in the rate of development, a decrease in survival, and a decrease in the percentage hatch of eggs of the killifish, Fundulus heteroclitus. These effects became more prominent as the dose was increased. (auth)

5663 ON A POSSIBLE RELATIONSHIP LINKING CELLULAR RADIOSENSITIVITY WITH GENETIC-CODING THEORY. Lionel Cohen (General Hospital, Johannesburg). Intern. J. Radiation Biol., 8: 93-5(1964).

The relation between the nuclear DNA content and mean lethal radiation dose expressed in rods and in terms of hits per nucleus was calculated for bacteriophages, bacteria, and plant and animal cells in tissue culture. The relation of target size and radiosensitivity is discussed. (C.H.)

5664 RADIATION CONDITIONING: A SPECIFIC AVERSION TO FEEDING AFTER A SINGLE EXPOSURE TO 50 r. E. V. Hulse and B. Claire Dempsey (Medical Research Council, Harwell, Berks, Eng.). Intern. J. Radiation Biol., 8: 97-9(1964).

A specific aversion to feeding was demonstrated in rats after exposure to 50 R x radiation. The technique was based on barium meals before serial radiographs. (C.H.)

5665 METABOLISM OF SERUM GLYCOPROTEINS IN THE X-IRRADIATED MOUSE WITH IMPLANTED RAT BONE-MARROW. Wallace Friedberg, Donald N. Faulkner, John K. Abbott, and Mary H. Friedberg (Federal Aviation Agency, Oklahoma City, Okla.). Intern. J. Radiation Biol., 8: 101-10(1964).

The concentrations of protein and protein-bound carbohydrate and the incorporation of glucosamine-1-^{14}C into serum fractions were measured in x irradiated (950 R) mice implanted with rat bone-marrow, in irradiated mice implanted with syngeneic (isologous) marrow, and in normal mice. The observations were made 23 days after irradiation, when atrophy of the splenic white pulp and the loss of body-weight indicated that the mice treated with rat marrow were undergoing the foreign-bone-marrow reaction. At this time the splenic white pulp of the mice treated with syngeneic marrow was repopulated, and body-weight had returned approximately to the pre-irradiation level. The rates of incorporation of glucosamine into serum-protein fractions were highest in the mice which had been given the rat marrow, which suggests an increased synthesis of serum glycoprotein. This group had the lowest concentration of alpha$_{1a}$-globulin-bound carbohydrate and the highest concentration of beta-globulin-bound carbohydrate. These animals also had the lowest concentrations of albumin and gamma globulin. Both irradiated groups had more intestinal helminths than the normal controls. (auth)

5666 APPARENT PEROXIDE ("PRO-BLUE") IN ORGANS OF IRRADIATED AND ALARMED MICE. V. J. Horgan and J. St. L. Philpot (Medical Research Council, Harwell, Berks, Eng.). Intern. J. Radiation Biol., 8: 165-76 (1964).

An improved anoxic box for estimating apparent peroxide, or pro-blue, in whole mice and mouse organs is described. The increase in pro-blue in whole mice given 5000 R x radiation was significant despite the more rigorous exclusion of air during extraction. In four organs of mice given 5000 R (epididymal fat, lungs, muscle, and skin) a significant increase of pro-blue was found. The mean total pro-blue in all organs, plus that in the residual carcass, was about 60 per cent of the mean in whole mice. Whole mice given 1000 R and macerated with n-butanol in air did not show a significant increase in pro-blue. The means for both control and experimental mice were higher than normally found with maceration in N_2. Mild alarm caused a significantly-increased pro-blue in the epididymal fat of males and in the ovarian fat of females. It is suggested that this may provide a mechanism for environmental effects on fertility. (auth)

5667 THE ACTION OF ULTRA-VIOLET LIGHT ON REPAIR OF X-RAY DAMAGE IN L-CELLS GROWN IN CULTURE. Antun Han, Branimir Miletić, and Danilo Petrović (Institut "Ruder Boškovic", Zagreb). Intern. J. Radiation Biol., 8: 187-90(1964).

L-cells are capable of considerable recovery after x irradiation. The processes responsible for recovery start promptly after irradiation. Cells irradiated with ultra-violet light do not display any recovery. The application of ultra-violet light to x irradiated cells led to partial inhibition of recovery after x rays. (auth)

5668 INVESTIGATION OF MOIST IRRADIATED SEEDS AND PROTEINS USING ELECTRON-SPIN RESONANCE. B. B. Singh, R. F. Cook, and A. Charlesby (Royal Military Coll. of Science, Shrivenham, Wilts, Eng.). Intern. J. Radiation Biol., 8: 195-9(1964).

Results are reported from an investigation of the electron spin resonance spectra of wheat and maize seeds and maize protein during ^{60}Co γ irradiation. It was concluded that the seed is a complex system with well-defined morphological

parts each with its own relative importance for germination and growth. Indirect evidence indicated that different species of free radicals are induced in the germ, pericarp, and endosperm. (C.H.)

5669 CYTOPHYSIOLOGICAL AND BIOCHEMICAL INVESTIGATIONS OF THE MICROORGANISMS DURING THEIR RESTORATION AFTER RADIATION INJURY. M. N. Meisel, T. S. Remezova, V. I. Biryuzova, R. D. Gal'tsova, G. A. Medvedeva, N. A. Pomoshchnikova, L. A. Seliverstova, M. N. Poglazova, A. I. Novichkova, and T. M. Volkova (Inst. of Microbiology, Academy of Sciences, USSR and Inst. of Radiation and Physico-Chemical Biology, Academy of Sciences, Moscow). Izv. Akad. Nauk SSSR, Ser. Biol., No. 6, 327-51(Nov.-Dec. 1964). (In Russian)

Postirradiation recovery was studied cytologically and physiologically in various species of yeasts. Recovery of yeast cells was greatly influenced by radiosensitivity and by conditions of cultivation prior to irradiation such as aeration, protein and lipid content of culture media, presence of reserve substances, avitaminosis, and starvation. From previous experiments on mechanism of action of radiomimetic substances, it is suggested that radiation recovery results in enzymatic disruption of cross-links between nucleic acid and protein molecules. (H.M.G.)

5670 A METHOD OF QUANTITATIVE ANALYSIS OF CHANGES ARISING AFTER IRRADIATION. G. N. Shangin-Berezovckii (Inst. of Genetics, Academy of Sciences, Moscow). Izv. Akad. Nauk SSSR, Ser. Biol., No. 6, 852-60(Nov.-Dec. 1964). (In Russian)

The estimation of the mutation process with the help of percentage of various plants and percentage of families involved in variability is critically analyzed on the basis of chlorophyll mutations in barley. The formula of variability level proposed is: $P_v = \alpha\beta\gamma$. This formula may be used to study the mutation process by every alternative character and relation of the type $(I-n)/n$. (auth)

5671 RELATIONSHIP BETWEEN ULTRAVIOLET SENSITIVITY AND ABILITY TO PROPAGATE ULTRAVIOLET-IRRADIATED BACTERIOPHAGE. Ruth F. Hill (Columbia Univ., New York). J. Bacteriol., 88: 1283-7(Nov. 1964).

Mutants with a reduced ability to propagate uv-damaged bacteriophage T_1 were isolated from Escherichia coli strain B/r. The change in this ability varied from a slight to a very marked loss; the greater the loss, the greater was the ultraviolet sensitivity of the mutant. Reduced ability to propagate irradiated T_1 appears to be the more sensitive index of genetic change, because in one mutant there was no significant reduction in ultraviolet resistance. In a converse study, second-step mutants with an increased ultraviolet resistance were obtained from a mutant of E. coli B. This mutant is both unable to propagate irradiated T_1 and very ultraviolet-sensitive. The increased ultraviolet resistance of the second-step mutants was not accompanied by an increased ability to propagate irradiated T_1. (auth)

5672 PHOTOREACTIVATION AND CYSTEINE REVERSION OF LYSOGENIC INDUCTION. Renana Ben-Gurion (Israel Inst. for Biological Research, Ness-Ziona). J. Mol. Biol., 9: 619-23(Sept. 1964).

Experiments are described with Escherichia coli K12 strains, the growth of which is inhibited in minimal media by the addition of 25 μg cysteine/ml. In such lysogenic (for λ) bacteria, induced by uv light, x rays or thymine deprivation, the addition of 2.5 μg/ml cysteine significantly decreased the number of induced cells. Cysteine at 2.5 μg/ml did not have any effect on thymineless death of the corresponding nonlysogenic strains, nor did it decrease the number of infected sensitive bacteria that produced phage. Photoreactivation of uv-irradiated lysogenic bacteria had an approximately constant dose reduction factor for induction, while cysteine had not. It was concluded that cysteine reverses the induction by interfering at a step different from the one which is reversed by photoreactivation. This cysteine-sensitive step does not appear to be involved in the vegetative production of the phage. Two strains, that were sensitive to the cysteine effect after uv induction, were induced by x rays, and their response to the addition of cysteine after this irradiation was tested. The number of the induced bacteria was determined in the same way as after uv irradiation, with the one difference that the number of induced cells was measured 20 min after irradiation, instead of 40 min after irradiation, because the latent period after x irradiation is shorter than after uv irradiation. The results indicated that after x irradiation cysteine reduces the number of induced cells. (BBB)

5673 THE CONTENT OF AMINO ACIDS IN THE PROTEINS OF THE DEVELOPING NERVOUS SYSTEM OF THE GUINEA PIG. IV. LONG-TERM EFFECTS OF PRENATAL X-IRRADIATION. Mieczyslaw Wender and Zbigniew Waligóra (Neurological Clinic and Inst. of Physiological Chemistry, Poznán, Poland). J. Neurochem., 11: No. 8, 583-8(Aug. 1964).

Fetal guinea pigs were exposed to a single dose of 400 R x radiation in the 8th or 9th week of gestation. The brain was subsequently examined histologically and samples of grey and white matter were subjected to chemical determinations of the amino acid content of the cerebral proteins at various periods of development. It was found that the amino acid composition of proteins of the fetal white matter differs significantly from the normal pattern. The amino acid levels in the proteins of both white and grey matter in the experimental animals was very constant throughout development. The normal developmental differentiation of the amino acid pattern in the proteins of the white and grey matter was almost absent in the prenatally irradiated animal. It was concluded that irradiation in the final period of gestation exerts a marked influence on protein biosynthesis in the developing brain of the guinea pig. The lasting, though slight, deviations of amino acid composition in the proteins of white and grey matter constitute a chemical malformation of the brain. (P.C.H.)

5674 PERSISTENT CHROMOSOMAL ABERRATIONS FOLLOWING RADIOIODINE THERAPY. Mohamed M. Nofal and William H. Beierwaltes (Univ. of Michigan, Ann Arbor). J. Nucl. Med., 5: 840-50(Nov. 1964).

A statistically significant increased incidence of chromosomal abnormalities both in count and morphology was observed acutely and to a lesser extent chronically after radioiodine therapy for hyperthyroidism. The abnormalities were detected as early as ½ hour after the therapy dose and were found to persist for at least 14 years after the treatment. The incidence and severity of abnormalities were greater after the larger treatment doses of ^{131}I for thyroid carcinoma, and in the period shortly after treatment. No hematological phenomena accompanied the chromosomal abnormalities. Apparently, no chromosomal aberrations could be attributed to the use of antithyroid drugs or to the thyroid status at the time of the study. (auth)

5675 BETA RADIATION OF CIRCULATING BLOOD BY AN IMPLANTED SHIELDED Y^{90} SOURCE, A PRELIMINARY REPORT OF TECHNIQUE. William H. Oldendorf, John T. Burroughs, Benedict Cassen, and Leonard W. Wetterau, Jr. (Veterans Administration Center, Los Angeles). J. Nucl. Med., 5: 883-6(Nov. 1964).

A technique is described in which chronic beta irradiation from ^{90}Y of circulating blood is achieved in vivo. Utilizing standard surgical techniques, a segment of the lower abdominal aorta of dogs is replaced by a flexible teflon arterial graft. A shield containing ^{90}Y beads is placed about the graft. Irradiation of blood is achieved through the graft material. After placement of the graft and shielded radioactive source, the animal's activities are not restricted. Two dogs subjected to this final form of the technique tolerated the procedure well. (auth)

5676 RELATIONSHIP BETWEEN RADIATION DOSE AND GIANT CELLS IN THE SURVIVING CELL POPULATION OF MOUSE MARROW AS DETERMINED BY INTERFERENCE MICROSCOPY. Hun Lee and Victor Richards (Presbyterian Medical Center, San Francisco). Nature, 204: 656-8(Nov. 14, 1964).

An investigation was made on the quantitative relation between radiation doses and the changes in cellular dry mass of the giant cells in the surviving mouse marrow cell population 24 hr following irradiation. LAF_1 male mice of approximately 20-33 g body weight and about 8-9 weeks of age were exposed to a single dose of whole-body x irradiation (200 kvp, 20 mamp, high-voltage layer, 1.35 mm Cu) in an individual plastic container. Some doses, namely, 1000 and 1500 R, were composed of two successive exposures with an interval between them of no more than 10 min. In the irradiated animals, the giant cells not only increased in number rapidly but also gradually expanded its ranges to higher values on the dry mass scale as the radiation dose increased. The percentages of giant cells with lower dry mass values were generally higher than those of the cells with higher dry mass values. The changes, as observed, are approximately proportional to the radiation dose. Two factors that contributed to the changes of giant cell distribution, namely, the increase in the number of giant cells and the increase in the dry mass of individual giant cells, are discussed. (P.C.H.)

5677 AMINOTHIOAMIDES AS PROTECTORS AGAINST THE EFFECT OF GAMMA-RAYS IN ALLIUM CEPA. M. D. El Khalifa (Univ. of Zagreb). Nature, 204: 708 Nov. 14, 1964).

The protective potentialities of a number of aminothioamides were tested against the action of gamma rays from a ^{60}Co source. Allium cepa seeds, variety White May, were germinated and seedlings with primary roots reaching 3-5 mm were selected and pretreated for 1 hr with a nontoxic concentration of the chemicals investigated. Then together with the respective solution the seedlings were irradiated. The results showed that aminothioamides were protective in Allium, though the degree of protection was lower than that shown by cysteine. The rest of the compounds tested having other substitutions were thoroughly ineffective. (P.C.H.)

5678 GROWING PLANTS UNDER A NUCLEAR REACTOR. Fred Wheeler. New Scientist, 24: 174-5(Oct. 15, 1964).

Design features are described for a plant irradiation facility in which plants are grown in nutrient solution below the reactor. The plants are observed by means of a closed-circuit television camera. The facility, known as the BARN (Netherlands Biological and Agricultural Reactor), will be used in studies of radioinduced mutations in plants. (C.H.)

5679 CYTOLOGICAL EFFECTS OF X RAYS ON DRY DORMANT SEEDS OF JUTE. Rabindra Krishna Basu (Bose Inst., Calcutta). Nucleus (Calcutta), 5: 75-86(1962).

Dry seeds of five varieties of jute (Tall Mutant, R 26, and Chinsura Green belonging to Corchorus olitorius and D 154 and D 386 belonging to C. capsularis) were irradiated with 14 x-ray doses ranging from 6×10^3 to 90×10^3 R. The treated seeds were allowed to germinate on moist filter paper in petri dishes, and the root tips were collected from the radicles when about 10 mm long. Somatic anaphase and telophase stages were studied in detail in the root tip cells in an attempt to elucidate the mechanism for the production of structural changes in the chromosomes. Counts of aberrant cells were taken from plerome and periblem and dermatogen combined. However, no actual difference in aberration frequency was observed in plerome in contrast to periblem and dematogen combined. The chromosomal aberrations in root tip mitoses increased with increase in x-ray dose and the relation was ~ linear. Evidence, based on interchange bridges (paired dicentric bridges) and fragments, is presented which indicates that the resting chromosomes behave for all practical purposes as monopartite, and the bridges and fragments result from chromosome rather than chromatid breaks. Single bridges, although they occurred, were very rare. Within the range of doses used the frequency of abnormal cells was greater with C. olitorius than with C. capsularis. (BBB)

5680 CYTOLOGICAL EFFECT OF X RAYS AND BETA RAYS IN X_1, P_1, AND S_1 POPULATIONS OF JUTE. Rabindra Krishna Basu (Bose Inst., Calcutta). Nucleus (Calcutta), 6: 1-16(1963).

Studies were made on: chromosomal abnormalities during meiosis in pollen mother cells, compared with those in root tip mitoses, the role of intrasomatic selections on the manifestation of chromosomal aberrations in pollen mother cells, and factors affecting variation in sterility and dimension of pollen grains following irradiation with x rays and ^{32}P and ^{35}S β rays on five varieties of jute. The dose of x rays on the dry seed of five different varieties ranged from 6×10^3 to 90×10^3R, and the treatments with ^{32}P and ^{35}S were from 0.005 to 5.0 μC per seed. A relation between dose and aberration frequency was not clearly observed during meiosis of X_1, P_1, and S_1 populations, although the treated populations exhibited increased frequency (in some cases significantly) of chromosomal abnormalities over that in the control. This suggests that during intrasomatic selections, the heavily aberrant cells were eliminated. The differences in the frequency of chromosomal abnormalities and pollen sterility in the treatments with respect to those of the control were analyzed statistically. Larger than normal pollen grains were observed in some of the X_1, P_1, and S_1 populations, and it is suggested that the decaying aberrant pollen mother cells induced by irradiation may serve as additional nutrients to the growing pollen grains causing them to grow bigger. A clear correlation between pollen sterility and ultimate plant height was observed as well as a decrease in ultimate plant height with increased pollen sterility. (TCO)

5681 THREE CASES OF TRISOMY IN THE MOUSE. A. B. Griffen and M. C. Bunker (Jackson Lab., Bar Harbor, Me.). Proc. Natl. Acad. Sci. U. S., 52: 1194-8(Nov. 1964).

The discovery of three different autosomal trisomics, which are classed as the primary or whole-chromosome type in x irradiated mouse populations, indicates that autosomal aneuploidy occurs in the mouse. Two of the trisomic individuals were sterile and the third semisterile; no external deviations from the normal phenotype were observed. In each case the trisomy involves members of the smaller chromosome classes. (auth)

5682 EFFECTS OF GAMMA RAYS ON MORTALITY, LONGEVITY AND FECUNDITY OF SOME SPECIES OF FRUIT FLIES. E. S. Narayanan, S. S. Chawla, and S. Ghai (Indian Agricultural Research Inst., New Delhi). Proc. Natl. Inst. Sci. India, Pt. B, 29: 613-21(Dec. 26, 1963).

The effects of gamma rays on mortality, longevity, and fecundity of some species of fruit flies showed that: the two days old pupae were very susceptible to the rays as exposure to 2,000 R brought 100% mortality in both the species studied; the resistance to the rays progressively increased with age; the fecundity was inversely proportional to the dosage used; the sterilizing effect started at about 2,000 R in the adults emerging from four to five days old irradiated pupae; and there was no apparent effect on the F_1 generation emerging from 1,000 R exposed pupae. (auth)

5683 MUTATIONS IN PLANT BREEDING. Horst Gaul (Max-Planck-Institut für Zuchtungsforschung, Cologne). Radiation Botany, 4: 155-232(Nov. 1964).

Applications of mutations in plant breeding are reviewed. Topics discussed include the characteristics and genetics of mutants, methods of breeding with mutations, the production of mutations, and the selection of mutations. Emphasis is placed on radioinduced mutations of barley. 391 references. (C.H.)

5684 DIFFERENTIAL RADIATION SENSITIVITIES OF RACES OF SEDUM PULCHELLUM MICHX. A USEFUL METHOD OF PLANT IDENTIFICATION. J. Frank McCormick (Savannah River Operations Office, AEC, Aiken, S. C.) and Wm. N. Rushing. Radiation Botany, 4: 247-51(Nov. 1964).

Two populations of each of three cytogenetic races (n = 11, n = 22, and n = 33) of Sedum pulchellum Michx. were

subjected to ionizing radiation during the seed and seedling stages of development. Seeds which received 0, 1450, 5800, 11,600, and 29,000 R at a rate of 1450 R/min from a ^{60}Co source exhibited a delay in germination at the end of one week which varied directly with the radiation dose received and inversely with the chromosome number. Two weeks after irradiation there was no significant difference in per cent germination. Seedlings which developed from irradiated seed exhibited decreased root growth which varied directly with the radiation dose received but did not vary directly with chromosome number. A simulation of root growth occurred in plants which received 1450 and 5800 R. Half of the seedlings which developed from irradiated seed were subsequently subjected to an additional 50,000 R (1450 R/min). These plants exhibited decreased root growth which varied directly with the total radiation dose received and at certain doses inversely with chromosome number. Ionizing radiation served as a useful tool to distinguish between morphologically indistinguishable seed and seedlings of different races of Sedum pulchellum Michx. Results from at least two of the three experiments indicated a direct relationship between chromosome number and radiation resistance. (auth)

5685 SURVIVAL OF CHLORELLA AND CHLAMYDOMONAS AFTER ACUTE AND CHRONIC GAMMA RADIATION. Herbert B. Posner and Arnold H. Sparrow (Brookhaven National Lab., Upton, N. Y.). Radiation Botany, 4: 253-7(Nov. 1964). (BNL-7426)

The relation between DNA content per cell and radiosensitivity of Chlorella and Chlamydomonas was studied. Cultures were exposed to chronic gamma radiation for 3 days at dose rates ranging from 0 to 75 kR/20-hr day or to 0 to 4 min. of acute gamma radiation (8 kR/min). On the basis of DNA content per cell, Chlorella was expected to be more radioresistant than Chlamydomonas. This expectation was fulfilled for acute exposures, but not for chronic. Survival curves for acute exposures show that Chlorella has an LD_{90} of 23 kR compared with 10 kR for Chlamydomonas. After chronic irradiation survival was reduced to 1 per cent by about 15 kR (5 kR/day) for Chlorella and 171 kR (57 kR/day) for Chlamydomonas. Various aspects of the results are discussed. (auth)

5686 A GROUP OF PLEIOTROPIC GENES WITH EXTENSIVE ACTION SPECTRA CORRESPONDING TO A NEW CASE OF POLYMERISM FOR PISUM. Werner Gottschalk (Universität, Bonn). Radiation Botany, 4: 267-74(Nov. 1964). (In German)

A group of 4 partially homogenic x-ray-induced mutants of Pisum sativum was studied. Mutant 241 A (crif crif) is fertile to a small extent, mutants 104 (cris, cris) 178 and 191 are sterile as females. Hybridization between those 4 mutants is therefore possible up to a certain limit. Genes crif and cris are pleiotropic, they show a remarkable conformity in their broad action spectra. However they can be clearly distinguished by small gradual differences in their activity. They are localized on different chromosomes, representing 2 polymeric genes unknown before. The gene of mutant 178 shows in 8 phenes of its action spectrum a general conformity with the genes just mentioned. It is however also responsible for building up additional anomalies. The small differences between mutants 104 and 191 are possibly due to the action of multiple alleles. (auth)

5687 ESR STUDIES ON PLANT SEEDS OF DIFFERENTIAL RADIOACTIVITY. I. EFFECT OF WATER CONTENT. S. Bhaskaran (Kernforschungszentrum, Karlsruhe, Ger.). Radiation Botany, 4: 285-9(Nov. 1964).

ESR studies on plant seeds of differential radiosensitivity were conducted with a view to evaluate the relationship between the production and decay of radicals and the observed differences in the radiosensitivity. Dry seeds (moisture content 5% and 2%) of Agrostis, tobacco, and mustard were x irradiated and the number of long lived radicals produced was determined. The yield of radicals in superdry seeds was much higher than in seeds of 5% moisture. At 5% level the yield of radical was least in mustard for a given dose as compared to tobacco and Agrostis. However, at 2% moisture content this relationship was altered in so far as mustard yielded the greatest number of radicals per gram for a given dose. It is suggested that some substance, probably an oil-sugar complex, in mustard may be involved in the modification of the detectable concentration of radiation induced free radicals. (auth)

5688 ESR STUDIES ON PLANT SEEDS OF DIFFERENTIAL RADIOSENSITIVITY. II. EFFECT OF OXYGEN AND NITRIC OXIDE AT DIFFERENT TEMPERATURES. S. Bhaskaran and W. Koehnlein (Kernforschungszentrum, Karlsruhe, Ger.). Radiation Botany, 4: 291-8(Nov. 1964).

Dry seeds of Agrostis, tobacco, and mustard, treated at 1 atm pressure with oxygen, nitric oxide, and heat were irradiated with x rays and free radical concentration was measured by the ESR-method. It was found that NO treatment for 110 hr decreases the radical yield, whereas heat-pretreatment did not affect the number of radiation induced radicals in comparison with seeds treated with O_2. From the shape of the resonance spectra at least two radical components were evident. The ratio of these two components varies with the treatment prior to irradiation. A possible explanation for the protective effect by NO and heat-pretreatment in seeds is given. (auth)

5689 RADIATION PHYSIOLOGY OF FRUIT—RESPIRATION DURING AND IMMEDIATELY FOLLOWING KILORAD DOSES OF IONIZING RADIATION. Roger J. Romani (Univ. of California, Davis). Radiation Botany, 4: 299-307 (Nov. 1964).

Several variables were incorporated in experiments designed to study the respiration of fruit undergoing irradiation. These included fruit type, fruit maturity, atmospheric composition before and during irradiation, and absorbed dose. Gamma radiation induced an immediate rise in respiration rate which continued to increase with prolonged exposure. The respiration response was not linear with dose, however, suggesting a transition zone in the tissue tolerance for radiation. With increasing physiological age the respiratory response both during and immediately following exposure was markedly reduced and may also reflect radiation tolerance. Anaerobic pre-treatment and irradiation did not appreciably change the post-irradiation respiratory pattern suggesting the prevalence of direct radiation damage. It was further shown that the immediate respiratory response to ionizing radiation was not mediated by radiation products external to the fruit. Radiobiological and metabolic implications of the data are discussed. (auth)

5690 QUANTITATIVE DOSE-RESPONSE OF PRUNUS FRUIT DECAY FUNGI TO GAMMA IRRADIATION. N. F. Sommer, E. C. Maxie, and R. J. Fortlage (Univ. of California, Davis). Radiation Botany, 4: 309-16(Nov. 1964).

The dose response of selected Prunus fruit decay fungi to inactivation of their colony-forming potential by gamma irradiation was studied. Included were Monilinia fructicola, Botrytis cinerea, Cladosporium sp., Penicillium expansum L, Rhizopus stolonifer, and Gilbertella persicaria. Dose inactivation curves were established for spores in vitro and end point studies provided an experimental estimation of the doses required to permanently inactivate all fungus cells in a high proportion of lesions. Thus, colony inactivation doses for 50, 80, and 90 per cent lethality were approximated for fungus populations of ca. 10 to 10^6 spores of all species irradiated in vitro. Similar data were obtained for the most destructive species after irradiation and incubation in their fruit host. Application of radiation as a tool for estimating the size of naturally occurring fruit lesions in terms of spore equivalents was suggested by results with inoculated fruits. A delay in colonization caused by radiation doses insufficient to permanently inactivate fungus lesions may provide a satisfactory control of decay in fruits having a short physiological life. (auth)

5691 SENSITIVITY OF CITRUS FRUIT DECAY FUNGI TO GAMMA IRRADIATION. N. F. Sommer, E. C. Maxie,

R. J. Fortlage, and J. W. Eckert (Univ. of California, Davis and Riverside). Radiation Botany, 4: 317-22(Nov. 1964).

Dose-response curves were established for spores of seven of the most damaging Citrus fruit decay fungi. Experimental determinations were made of the doses required to inactivate every cell in a high proportion of fungus populations of various sizes. Particular attention was given to Penicillium italicum and P. digitatum, causes of the very destructive blue and green mold decays. Comparisons were made of sensitivity between irradiation in vitro and in vivo; with or without cold storage between irradiation and incubation; and between conidia and young hyphal cells. (auth)

5692 THE RADIATION RESPONSE OF PHYCOMYCES—STRUCTURAL AND BIOCHEMICAL EFFECTS. A. Forssberg, V. Stankovic, and A. Pehap (Karolinska Inst., Stockholm). Radiation Botany, 4: 323-30(Nov. 1964).

Low dose x radiation caused reversible changes in growth rate and biochemical systems in the sporangiophore of Phycomyces. The question is whether the growth effects are initiated by prior biochemical ones or whether both are secondary to structural lesions. Auxin occurs in an equilibrium of free ⇌ bound molecules in the cytoplasm. In cultures where the concentration of free auxin is low, x ray exposure releases after 5 min. further free auxin, but not more than the maximum found in any unexposed cultures. In the range 6 to 140 R the yield was not increased with the dose. The hypothesis is that x rays break a fraction of particularly labile auxin-substrate bonds. Direct hits on the sites of binding cannot account for the effect quantitatively. Changes in growth rate and in auxin content show similar dose independence and general course of reaction; this points to a logical connection. The microstructure of the growth zone suggests however a radiosensitivity apart from any biochemical interaction and most of the experimental evidence indicates that growth rate and biochemical events are independent and secondary to structural lesions. The results indicate that low doses of radiation may cause marked cytoplasmic effects. (auth)

5693 A CYTOLOGICAL STUDY OF THE "FREE NUCLEAR DIVISIONS" IN MACROZAMIA COMMUNIS (JOHNS.) CARRIED OUT ON γ-IRRADIATED MATERIAL. W. Wittmann (Australian National Univ., Canberra). Radiation Botany, 4: 331-40(Nov. 1964).

An investigation of the free nucleate stage of the young female prothallus (endosperm) and the early embryogeny in Macrozamia showed that karyokinesis and cytokinesis occur as closely associated as in typical somatic cell divisions. Failure to form a stainable cell membrane did not lead to a coenocytic arrangement. The protoplasts remained separated by the plasma membranes. Wall formation did not depend on the occurrence of secondary spindles. The developing cell walls gave rise to the spindle-like structures which are due to striations in the walls themselves and to cytoplasmic strands in what are already differentiated cells with vacuoles and resting nuclei. The gamma irradiation served merely to clarify and accentuate the cytological details in the cytoplasm. (auth)

5694 THE ACTION OF FAST HEAVY IONS ON BIOLOGICAL MATERIAL. II. EFFECTS ON T1 AND φX-174 BACTERIOPHAGE AND DOUBLE-STRAND AND SINGLE-STRAND DNA. Philip E. Schambra and F. Hutchinson (Yale Univ., New Haven). Radiation Res., 23: 514-26(Dec. 1964).

The relative killing efficiency of ^{60}Co γ-rays, and He, C, O, F, Ne, and Ar ions of ~10 Mev per nucleon, covering a LET range of ~10 to 10^4 Mev-cm^2/gm, was investigated for T1 and φX-174 bacteriophage in the dry state. A marked difference in sensitivity dependence of these two phages on LET was found and ascribed to differences in virus nucleic acid. For φX-174, containing single-stranded DNA, the inactivation was in accord with that expected from simple target theory. The inactivation of double-stranded DNA in T1 followed a much more complicated course, and it was highly likely that at least two different processes of inactivation take place. (auth)

5695 RADIATION STABILIZATION OF GLYCOSIDES BY AROMATIC GROUPS. Glyn O. Phillips, Florine A. Blouin, and Jett C. Arthur, Jr. (Dept. of Agriculture, New Orleans). Radiation Res., 23: 527-36(Dec. 1964).

On γ-irradiation of crystalline methyl α-D-glucopyranoside, the main chemical effect is scission at the glucosidic link to form glucose (initial G 2.33). Infrared studies indicate that the accompanying acid formation (initial G 1.45) occurs directly in the solid state. Acetylation and a change in configuration at C-2 in the glycoside have little effect on the G value for glycosidic bond cleavage. Introduction of aromatic groups into the molecule exerts a marked stabilizing influence, as demonstrated by the low G values for glycosidic cleavage for phenyl β-D-glucopyranoside (0.8) and tetra-O-benzoylphenyl β-D-glucopyranoside (0.05). It is not necessary that aromatic groups form the aglycon portion to ensure protection of the glycoside, as shown by the marked resistance of tetra-O-benzoylmethyl α-D-glucopyranoside to radiation damage. It is suggested that protection arises mainly from intramolecular energy transfer effects which can extend beyond the length of one glucose molecule, as indicated by the low initial G value for scission of the disaccharide bond in hepta-O-acetylphenyl β-maltoside (0.10); cleavage of the phenyl group occurs with initial G 0.05. (auth)

5696 RELATIVE CYTOGENETIC EFFICIENCY OF MUONS AND π^- MESONS IN ZEA MAYS (L.) AND ITS MODIFICATION BY POSTIRRADIATION STORAGE. Alexander Micke, Harold H. Smith, Robert G. Woodley, and Alfred Maschke (Brookhaven National Lab., Upton, N. Y.). Radiation Res., 23: 537-50(Dec. 1964). (BNL-7959; BNL-7959-R)

Dormant seeds of a stock of Zea mays L. heterozygous for the yellow-green alleles Yg_2/yg_2 were irradiated with muons (μ^- particles) and negative π mesons (π^- particles) from the Alternating Gradient Synchrotron at Brookhaven National Laboratory. The efficiency of muons was 0.76, and that of π^- mesons was 3.23, compared with 250-kvp x rays. Postirradiation storage for ~18 weeks increased the efficiency of muons to 1.58, and that of π^- mesons to 4.14. The hight RBE of π^- mesons was found only for the tested chromosomal damage or alteration, not for biological parameters involving germination and growth. (auth)

5697 THE INFLUENCE OF FRACTIONATED X-IRRADIATION ON THE INTESTINE OF RATS PROTECTED BY CYSTEINE AND PARTIAL-BODY SHIELDING. M. F. Sullivan and R. C. Thompson (General Electric Co., Richland, Wash.). Radiation Res., 23: 551-63(Dec. 1964). (HW-SA-3498)

Survival of rats after fractional whole-body x irradiation with individual doses up to 500 R was not limited by intestinal damage, nor was it increased appreciably by pretreatment with cysteine. Protection of hematopoietic tissue by shielding the thoracic region or by shielding all the body, except an area of the abdomen containing 90% of the intestine, increased survival so that the resistance of the intestine to protracted radiation could be studied. Cysteine prophylaxis, in the presence of partial-body shielding, resulted in a marked decrease of intestinal damage and increased survival from semiweekly x irradiation. Pathologic damage to the skin and abdominal wall of exposed areas was often quite severe, in contrast to the relatively good condition of the intestine after repeated irradiation of shielded and cysteine treated rats. The large bowel often showed more changes than the small intestine after repeated irradiation. The survival of rats after conclusion of protracted exposure was markedly decreased. The nature of the residual damage responsible for this life shortening was not clearly defined but was most probably due to incomplete repair of intestinal injury. (auth)

5698 DARK RECOVERY PHENOMENA IN YEAST. II. CONDITIONS THAT MODIFY THE RECOVERY PROCESS. M. H. Patrick and R. H. Haynes (Univ. of Chicago). Radiation Res., 23: 564-79(Dec. 1964).

The dark recovery kinetics of x- or uv-irradiated diploid yeast (Saccharomyces cerevisiae) are dose-dependent,

since both the initial lag and the time required to attain maximum viable titer are increasing functions of dose. The recovery process exhibits temperature and pH optima close to 30°C and pH 6.0, respectively; addition of certain monovalent and divalent cations to the irradiated suspensions can partially inhibit recovery, but for other ions enhancement of recovery is seen. These results support the view that dark recovery of radiation damage in yeast is due to the action of an enzyme or enzyme system. Although the optimal conditions for dark recovery are in many ways similar to those for growth, the two processes appear to be mutually antagonistic. The reduction in recovery observed on addition of nutrients to the storage medium suggest that, once a cell is committed to postirradiation multiplication, it is incapable of recovery. Storage of irradiated cells either under nitrogen, or in the presence of metabolic antagonists such as 2,4-dinitrophenol, potassium cyanide, or sodium azide, can significantly reduce the final level of recovered viability. Conversely, storage under increased oxygen tension, or in the presence of ATP (but not AMP) or chloramphenicol, enhances recovery after x or uv irradiation. This suggests that energy is required for the repair reactions and that it must be supplied primarily through oxidative metabolism in the form of ATP. Treatment of yeast with DNA-specific agents such as ethyl methane sulfonate or acridine dyes serves to inhibit recovery after either x or uv irradiation. In addition, recovery can be inhibited by treatment with protein-specific agents, such as heat (60°) or caffeine. These effects probably reflect, on the one hand, excessive structural alteration of the DNA substrate and, on the other, damage to the repair enzymes involved. (auth)

5699 WHOLE-BODY IRRADIATION IN THE YOUNG PIG: GROWTH, HEMATOLOGY, AND METABOLISM OF CALCIUM-45 AND STRONTIUM-89. R. S. Lowrey and M. C. Bell (Univ. of Tennessee, Oak Ridge). Radiation Res., 23: 580 93(Dec. 1964).

A total of 66 young growing pigs was used in a series of three experiments to study the effects of whole body ionizing irradiation (450 R) on growth, feed intake, hematology, and the metabolism of ^{45}Ca and ^{89}Sr. Irradiation had no effect on the growth rate or feed intake of the pigs during the 35-day period. White blood cell counts dropped rapidly after irradiation, reaching a low point 4 days postirradiation, then recovering slowly, reaching about 75% of normal values 56 days after irradiation. Platelet counts were depressed after irradiation, reaching a low point at 11 to 15 days and returning to normal by 32 days. Irradiated animals retained significantly more ^{89}Sr when orally dosed 1 day postirradiation, but there was no difference in retention between irradiated and controls when the animals were dosed 21 days postirradiation. The increased retention was a result of decreased fecal excretion of ^{89}Sr. Irradiation had no effect on the retention of orally administered ^{45}Ca, nor any effect on the urinary or fecal excretion of intravenously administered ^{45}Ca and ^{89}Sr. Histological examination of the digestive tract revealed no differences between irradiated and control animals. Ratios of ^{89}Sr to ^{45}Ca for excreta and tissues indicate that the discrimination against strontium occurs mainly in the gastrointestinal tract. (auth)

5700 ENZYMATIC CHANGES IN BETA-IRRADIATED EPIDERMIS OF GUINEA PIGS: EXTRACELLULAR AND INTRACELLULAR DEOXYRIBONUCLEASES I AND II. Joseph Tabachnick, Jerome S. Perlish, and Richard M. Freed (Albert Einstein Medical Center, Philadelphia). Radiation Res., 23: 594-602(Dec. 1964).

Epidermal DNases I and II of albino guinea pigs were separated into extra- and intracellular fractions by washing excised whole tissue with 0.25 M sucrose, prior to homogenization. After a single skin surface dose (in vivo) of 3000 rep of β radiation from a ^{90}Sr-^{90}Y sealed source, there was a progressive increase in activity of extracellular DNase I. A significant increment occurred as early as the first day, well before any detectable histologic changes; it reached a peak, about 6.5 times the control value, by the tenth day, and remained at this level to the sixtieth day. Intracellular DNase I increased about twofold by the tenth day. Extracellular DNase II activity was not significantly affected by 3000 rep of β radiation, but there was a significant decrease in intracellular DNase II 24 hours after irradiation; it remained at a lower level to the sixtieth day. The two mechanisms most likely to account for the increase in extracellular DNase I were considered to be an increase in dermal vascular permeability or release of the enzyme from dead and dying epidermal cells. (auth)

5701 STRAIN VARIATION IN REPRODUCTIVE CAPACITY AND RADIATION RESPONSE OF FEMALE MICE. U. H. Ehling (Oak Ridge National Lab., Tenn.). Radiation Res., 23: 603-10(Dec. 1964).

From 14 to 18 female mice of each of the strains SEC (dse/dse), A, SEA, NB, and DBA were irradiated with 50 R of x rays. One day after exposure, each female was caged separately with a nonirradiated C3H male for the duration of the experiment. Equal numbers of nonirradiated females were mated in the same way. The total reproductive performance of irradiated and nonirradiated females was determined. The number of offspring per female after exposure with 50 R, expressed as percentage of comparable control group, was as follows for the various strains: SEC (15%), A (18%), SEA (19%), NB (32%), and DBA (56%). For the most radiosensitive strain (SEC), the total numbers of offspring per female (mean and standard error) in the control and 50-R groups were 73.4 ± 0.4 and 11.0 ± 0.9, respectively; for the most radioresistant strain (DBA), the corresponding values were 40.4 ± 3.7 and 22.5 ± 1.6, respectively. In addition, the fertile period of irradiated DBA females was three times as long as that of irradiated SEC females. Expressed as a ratio relative to DBA, the postirradiation production of litters per female by the various strains was as follows: DBA (1.00), NB (0.45), SEA (0.34), A (0.31), and SEC (0.25). Comparisons of radiation response between species must take the three- to four-fold difference between strains within species into consideration. (auth)

5702 THE EFFECTS OF X-IRRADIATION ON THE DOMINANCE BEHAVIOR OF THE ADULT FEMALE BEAGLE: A METHODOLOGICAL PROBLEM. Andrew K. Solarz (Univ. of California, Davis). Radiation Res., 23: 611-19(Dec. 1964).

Fifty-five pairs of adult female beagles that were exposed (or sham-exposed) to whole-body x irradiation at an early age were observed over a two-year period for dyadic dominance submission interaction. D-S was classified along an intensity dimension. Interactions between D-S, magnitude of x irradiation, and body weight were analyzed. Preadult dyadic weight difference was found to be a primary determiner of D-S in the adult pair. This factor overrode any influence of x irradiation. Adult weight is partly determined by intensity of dominance or submission within the pair. The mean weight difference favoring dominance was 16 ounces. Housing of experimental animals, when weight is to be a critical evaluation variable, is discussed as a methodological problem. (auth)

5703 PLASMA AND ADRENAL GLAND CORTICOSTERONE LEVELS AFTER X-RAY EXPOSURE IN RATS. J. M. Abdul Hameed and Thomas J. Haley (Univ. of California, Los Angeles). Radiation Res., 23: 620-9(Dec. 1964). (UCLA-12-527)

Total-body x irradiation in rats with 650 R caused a marked increase in both the plasma and the adrenal corticosterone levels at 2.5 hours postirradiation. The hormone levels in the plasma returned to control levels at 24 hours and showed a less marked but significant rise at 48 hours. The steroid concentrations in the adrenal gland remained elevated for 48 hours, decreased on postirradiation days 5 and 7, and returned to control levels by day 14. Irradiation of the head alone produced a rise in both plasma and adrenal gland steroid levels at 72 hours, with return to control values on the succeeding day. Irradiation of the body only resulted in an increase in the steroid concentrations of the plasma and the adrenal gland at 2.5 hours with a return to

control levels by 24 hours. The statistically nonsignificant elevations of plasma steroid levels in both the head and body experiments are being investigated further. In hypophysectomized rats, no increase in corticosterone concentrations in either the plasma or the adrenal gland was observed after x irradiation, thus excluding a specific stimulating effect on the adrenal gland. Steroidogenesis in the adrenal gland, however, was somewhat depressed after whole-body and localized body irradiation but not after localized head irradiation. Data obtained after pretreatment of the animals with an adrenal-cortical inhibitor indicated that this direct depressing effect of radiation of the adrenal gland was not sufficient to prevent the adrenals from responding to the adrenocorticotrophic hormone. The results are consistent with the hypothesis that radiation acts as a nonspecific stressor. (auth)

5704 THE EFFECT OF RADIATION ON THE DEOXYRIBONUCLEIC ACID-BINDING CAPACITY OF HEMOGLOBIN. Eric L. Nelson and Joyce Cohen (Univ. of California, Los Angeles). Radiation Res., 23: 641-7(Dec. 1964).

Standardized hemoglobin solutions from ^{51}Cr-labeled erythrocytes react with DNA to give precipitates that can be measured in terms of their radioactivity. The reaction is quantitative and measures the DNA-binding capacity of the hemoglobin. Binding capacity of hemoglobin is a constant for a given animal but may be shown to vary after exposure of the animal to x radiation. It is suggested that studies on the DNA-binding capacity of hemoglobin may lead to a convenient method for determining the biologic effect of radiation. (auth)

5705 CREATINE METABOLISM AFTER X-IRRADIATION. G. B. Gerber, G. Gerber, T. R. Koszalka, and L. H. Hempelmann (Univ. of Rochester, New York and CEN, Mol, Belg.). Radiation Res., 23: 648-52(Dec. 1964).

Four groups of rats were exposed to 600 R or whole-body x irradiation. One group (A) was shielded with lead in such a way that only the right leg was exposed to radiation. Another group (B) was shielded so that the entire body was exposed except for the left leg. In a third group (C), the total body was irradiated, and a fourth group (D) was sham-irradiated. Forty-eight hours after exposure, each rat was injected intraperitoneally with 4 μC of creatine-1-^{14}C. After injection of the labeled creatine, urine was collected for two consecutive 12-hour periods, and the concentrations of creatine and creatinine were estimated. Creatine was isolated from the urine and muscle, and its specific activity was determined. Significant differences were observed between the specific activities of creatine isolated from exposed or nonexposed muscle of x irradiated animals and that from nonirradiated animals. The specific activities of muscle from nonexposed and exposed legs were also significantly different, regardless of whether or not the rest of the body had been exposed. The ratio of specific activity of muscle creatine to urinary creatine was lowest in animals exposed to total-body irradiation and in those in which only one leg was shielded. The data indicate that radiation-induced creatinuria is, in part, the result of a direct exposure of the muscle and, in part, an abscopal effect. (auth)

5706 PRELIMINARY OBSERVATION OF THE ULTRASTRUCTURE OF IRRADIATED LATEROCERVICAL LYMPH NODES. G. Poggi Longostrevi and I. Milanesi (Università, Milan and Ospedale di Circolo, Desio, Italy). Radiobiol. Latina, 6: 223-32(July-Sept. 1963). (In Italian)

Alterations, as seen with the electronic microscope, on latero-cervical lymph nodes of the rat following one single localized irradiation with a dose of 900 R x radiation are described. During the first days following irradiation modifications were seen in the mytochondril structures in the lymphocytes and in the lymphoblasts, further a loosening of the endoplasmatic reticulum of the plasma cells, cytoplasmatic edema, and alterations of the intercellular boundaries in the reticular cells with fibers, as well as various alterations of the morphology of the inclusion bodies in the reticular cells. (auth)

5707 WHOLE-BODY IRRADIATION AND HYPOXIA: MODIFICATION OF THE ULTRASTRUCTURE AT THE LEVEL OF THE INTESTINAL EPITHELIUM. G. Poggi Longostrevi, A. Squassabia, and R. Sorrentino (Università, Milan and Ospedale Maggiore, Novara, Italy). Radiobiol. Latina, 6: 247-315(July-Sept. 1963). (In Italian)

The influence of the hyperoxygenation combined with pan-irradiation on intestinal cells of mice showed a clear-cut increase of damage, particularly two and four days after combined treatment. Modifications observed included changes in the free surface of the intestinal epithelial cells, which are largely deprived of the microvilli of the striated cuticle as well as the stroma of the terminal web. The perinuclear space appeared to be enlarged. Further, characteristic vacuolar formations were found which contained granula. Even the mitochondria appeared to be swollen and to loose their cristae. (auth)

5708 EFFECTS OF SOME CATALASE INHIBITORS ON IRRADIATED HUMAN AMNIOTIC CELL CULTURES. G. Poggi Longostrevi, L. Donati, and B. Beffagna (Università, Milan). Radiobiol. Latina, 6: 339-55(July-Sept. 1963). (In Italian)

With the aim of clearing the mechanism of action of the enzyme catalase and of its inhibitors (INI, sodium azide, hydroxylamine) in the presence of ionizing radiations, a morphological and biochemical investigation was made, using as a biological substratum the human amniotic cells of the stabilized F.L. strain. A count was made of cells of nuclei to establish the curves of growth of the cultures, and determination of the maximum dosage of the inhibitors which were employed, determination of the anticatalatic activity of cells in various conditions, extraction and determination of DNA and RNA of the cells were carried out. Some interesting aspects could be established of the interaction x rays with catalase inhibitors. Attention is called to the anticatalatic and radiosensibilizing action of hydroxylamine; to the radioprotecting action of sodium azide; to the lack of sensitizing and anticatalising action of the doses of INI used. Some theories are drawn for the explication of the Euler phenomenon in the experimental conditions. (auth)

5709 HISTOMETRIC STUDY OF MORPHOLOGICAL VARIATION OF IRRADIATED HEPATOCYTES. G. Poggi Longostrevi (Università, Milan). Radiobiol. Latina, 6: 377-88(July-Sept. 1963). (In Italian)

The results obtained by the use of the histometric technique according to Chalckley for an examination of the dimensional relative variations of the hepatic cytoplasmatic ultrastructures in rats treated by a single 800 R x ray dose localized on the animals' hepatogastric region are reported. This method allows a direct evaluation of the percentage relationships existing between the surface of the microscopic field occupied by one formation and the one occupied by the others. The cytometric observations established that there exists a diffuse swelling of the cytoplasmatic cellular structures as those of the cytoplasmatic reticulum, which takes place in two stages, as it appears about 16 hours after irradiation and then again at the end of the first week. The primitive swelling appears to be related to a disturbance of the water metabolism (cellular edema) which, on hand of the enlargement allowed by the electron microscope, is due to an over-distention of the reticulum cavities which, on observation at the optic microscope, give to the cell the aspect of vacuolar degeneration. These considerations derive from an analysis of graphs reported which show that the modifications of the ground substance precede those of the reticulum. Conversely, non-marked variations were found of the extension of the cytoplasmatic surface occupied by mitochondria which show only a slight swelling during the first two weeks following irradiation. Attention is finally called on the possibilities of utilizing the method presented for the investigation of quantitative alterations of ultrastructures. (auth)

5710 SERUM ENZYMES DURING IRRADIATION OF TUMORS OF THE UPPER RESPIRATORY TRACT. M. Pesenti and E. Tazzi (Università, Milan). Radiobiol. Latina, 6: 389-98(July-Sept. 1963). (In Italian)

Data obtained from a determination of the serum enzyme contents in two groups of patients, the first suffering from lymphatic new-growths and the second from epithelial new-

growths localized in the upper airways during radiotherapy are reported. The meaning of the enzymatic determinations in the serum in these diseases is discussed. (auth)

5711 ACTUAL POSSIBILITIES IN THE FIELD OF RADIOSENSITIZATION. R. Sorrentino (Ospedale Maggiore, Novara, Italy). Radiobiol. Latina, 6: 399-413(July-Sept. 1963). (In Italian)

A literature survey was made of studies on the radiosensitization of animals. 154 references. (C.H.)

5712 THE SIGNIFICANCE OF ELECTROLYTE BALANCE IN THE DIFFERENTIATION OF INTERINDIVIDUAL RADIOSENSITIVITY IN MICE. M. Pospíšil (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Radiobiol. Radiotherap., 5: 517-24(1964).

The 24 hours' excretion of sodium and potassium in the urine of starved mice was followed prior to irradiation. The division of the variation range of the electrolyte values into several narrower class intervals and their correlation with the weight of the thymus 24 hours after the total body irradiation of the mice with a dose of 100 R has shown the parabolic dependence of the two values. The extreme variants of the electrolyte metabolism are accompanied by the highest degree of thymolysis. In further experiments the mortality of mice after total body irradiation with a dose of 660 R was taken as the criterium of radiosensitivity. When comparing this parameter with the electrolyte excretion prior to irradiation the same parabolic dependence is established. Mice with extreme variants of electrolyte balance exhibit a higher radiosensitivity, while mice of the mean type have the highest survival. The experiments showed possibilities of a reduction in the variability of experimental results. (auth)

5713 THE CHANGE OF STORAGE IRON IN THE LIVER OF RATS FOLLOWING WHOLE-BODY IRRADIATION. G. P. Wildner, H. Braselmann, E. Seidler, and O. Keim (Humboldt-Universität, Berlin). Radiobiol. Radiotherap., 5: 525-31(1964). (In German)

Following whole-body x irradiation of rats with 500 R, a temporary significant increase of the content of storage-iron in the liver is to be stated that is increased after 700 R and occurs in a shorter period after irradiation. The decreased utilization of the iron from the food and metabolism due to radiation injury of the bone marrow is regarded as the cause. The unused iron is deposited in the liver preponderantly in the ferrit infraction of the storage-iron. (auth)

5714 THE BEHAVIOR OF THE PARTICULAR COMPONENTS OF C-17-KETOSTEROIDS IN URINE IN RADIATION THERAPY OF TUMORS WITH RESPECT TO THE GENERAL DETERMINATION. K.-H. Riessbeck (Homboldt-Universität, Berlin). Radiobiol. Radiotherap., 5: 545-50(1964). (In German)

The relations between the behavior of the general determination of 17-ketosteroids and the particular fractionation groups and isolated substances, respectively, under radiation therapy of tumors are reported. The observed remarkable agreement between the particular parts and the general determination explains their good applicability for indicating the radiation responses of tumors. This good homogeneity of the behavior of the particular fractionation groups and isolated substances, respectively, is causally related to the central regulation system which becomes effective by the influence of ionizing radiation on tumorous events. The 11-hydroxysteroids and dehydroepiandrosterone show due to their great metabolic relations in dependence on adrenocorticotropic hormone a somewhat more pronounced reactivity than α-steroids which are additionally involved in a broad scale of metabolic tasks and due to this complex task and dependence cannot demonstrate such a clearness in the reaction as the other cited substances in the radiation responses of tumors. The experimental results of these examinations in particular are to be recommended in other publications. (auth)

5715 ROENTGENOLOGICAL EXAMINATIONS TO THE FUNCTION OF THE STOMACH FOLLOWING RADIATION ACTION. W. Schmidt (Medizinische Akademie, Magdeburg, Ger.). Radiobiol. Radiotherap., 5: 633-7(1964). (In German)

For the study of functional changes in the human stomach following radiation action 40 patients with highly dosed postoperative x irradiation to the cavity of the thorax (10 patients) or the pelvic space (20 patients) had to undergo 80 roentgenological examinations of the stomach before and after irradiation. The examined criteria, frequency and depth of the peristalsis, tonus, time of evacuation for the first swallow of the meal as well as evacuation of the stomach two hours after administration of the meal, showed after the action of ionizing radiation not uniform reaction and no significant differences before and after irradiations of the cavity of the thorax or the pelvic space as well as in comparing these two groups one to another. The capability of evacuation of the stomach for the first swallow of meal showed before and after irradiation a clearly contrasting behavior that was interpreted by Wilder's law of starting value. From our results we might not give the decisive part in the development of the intestinal radiation reaction to the stomach. (auth)

5716 EFFECT OF IONIZING RADIATION OF THE GERMINABILITY OF JUTE SEEDS. Subir Sen (Kalyani Univ., Mohanpur, India). Sci. Cult. (Calcutta), 30: 388-90(Aug. 1964).

The effects of γ and x radiations on germinability of jute seeds were studied in two varieties. X-ray doses from 20,000 to 100,000 R and γ-ray doses from 40,000 to 200,000 R were used to irradiate the dry seeds of the two strains. Results clearly indicated the nonexistence of proportionality between radiation dose and effect on growth, particularly in the case of x irradiation. The different response of the two strains to the different types of radiation was also obvious. Lethal dose of both types of radiation was determined for both strains. (H.M.G.)

5717 UTILIZATION OF UV AND X RAYS IN HYBRIDIZATION BETWEEN VARIETIES AND BETWEEN SPECIES OF FRUIT TREES. V. I. Ostapenko. [Vestn. Sel'skokhoz. Nauki, Vses. Akad. Sel'skokhoz. Nauk] 9: No. 3, 92-9(1964). (In Russian)

Investigations showed that irradiation with ultraviolet and x rays intensifies oxidation and reduction processes in pollen, and it results in the increase of efficiency of intervarietal and remote hybridization. (auth)

5718 TUMORS FOLLOWING SINGLE X IRRADIATION OF WHITE RATS OF VARIOUS AGES. U. Reincke, E. Stutz, and G. Wegner (Universität, Freiburg i. B.). Z. Krebsforsch., 66: 1650-86(1964). (In German)

Four groups of male or female rats were irradiated with a single whole-body dose of 270 R of x radiation. The ages of the groups were 5 days prenatal, and 13, 49, and 121 days after birth. A fifth group consisted of gravid females 121 days old. These were compared with a sixth group of nonirradiated control animals. The 30-day mortality after prenatal irradiation was 44%, but the mortality in postnatal irradiation groups ranged from 0 to 9%. The growth of the animals that survived intrauterine irradiation was retarded, and microencephaly, combined with unilateral or bilateral microphthalmia, or genital hypoplasia were observed in ~90% of the animals. Life expectancy was reduced from 3 to 6 months in all groups, independently of the age when irradiated. In 512 irradiated animals 402 benign and malignant tumors were diagnosed histologically. There were 44 tumors from among 118 control animals. No tumors were observed in the liver, thyroid, or central nervous system. Tumor incidence in males and females increased by 4 and 10 times, respectively, as compared to the incidence in the controls. In females the proportion of benign mammary and polyposis uteri was greatly increased. Most of the female genital tumors were found in the animals irradiated postnatally. Incidence of benign tumors was highest in the animals irradiated at 13 days, consisting largely of ovarian tumors, and fewer mammary tumors were observed in gravid animals. Incidence of polyposis uteri increased with

age when irradiated, but radiation sensitivity was not related to age or to irradiation in utero. (BBB)

5719 THE GENERAL CLINICAL REACTIONS AFTER LOCAL X IRRADIATION OF HORSES AND CATTLE. W. Bolz (Landwirtschaftliche Hochschule, Stuttgart). Zentr. Veterinaermed., 11: 427-44(July 1964). (In German)

Local doses of ~2000 R of 90-kv x rays were given to horses and cattle in daily fractions, usually in the thoracic region, and hematologic and clinical reactions were observed. The systemic clinical effects after x irradiation of the chest wall were easier to demonstrate than changes in the blood picture. In the horse, eight hours after irradiation there occurred increases in temperature, pulse rate, and respiration which varied little with the dose. Respiration which varied little with the dose. Respiration was the most reliable indicator of irradiation and it sometimes also became painfully deep and slower. When lung irradiation was frequently repeated, the increases in temperature, pulse rate, and respiration continued for about 30 days. In cattle the effect of irradiation on respiration was best seen in the first five hours. Rectal temperature usually rose in the first hours by 0.5 to 1°C, whereas there was little effect on pulse rate. Calves under six weeks old showed in the first six hr stertorous breathing and loss of appetite and on the following day a serous nasal discharge and brief bouts of coughing. An appreciable fall in blood lymphocytes was seen at about seven hours in cattle, whereas in the horse this drop occurred earlier, or in about three hours. A drop in circulating platelets was observed in both species, from about the third hour postirradiation. Fluctuations in counts of the various types of leukocytes are described in detail. (BBB)

Radiation Effects Therapy and Countermeasures

5720 (AD-601839) SYNTHESIS OF STEREOSPECIFIC AMINOTHIOLS AS RADIOPROTECTIVE AGENTS. Progress Report, July 1, 1962–March 1, 1963. J. Cymerman Craig (California. Univ., San Francisco. Medical Center). Contract DA-49-193-MD-2145. 3p. $0.50(OTS).

The synthesis of cis-2-aminocyclopentanthiol from 2-methylcyclopentanothiazoline was found to be not practicable. The following were obtained as intermediates: S,N,N-tribenzol-cis-2-aminocyclopentane (m.p. 167-1680); S-acetyl-cis-2-benzamidocyclopentanethiol (m.p. 132-133C); S-acetyl-cis-2-acetamidocyclopentanethiol (m.p. 63-64C); cis-1-acetyl-2-methyl-4-oxobicyclo-(5.0.3)-1-aza-5-thiadec-2-ene (m.p. 137.5-139C). (auth)

5721 EFFECT OF KCN ON RADIOSENSITIVITY OF EHRLICH ASCITES TUMOUR CELLS. V. Drášil and Věra Jurášková (Inst. of Biophysics, Brno). Folia Biol. (Prague), 10: 366-72(1964).

Cells of diploid Ehrlich ascites tumor were irradiated with x rays in the presence of KCN at +20°, −78° and −196°C. It was found that KCN, at room temperature, more than doubled the radiosensitivity of the tumor cells (DRF = 0.45). An increase in radiosensitivity was observed only in suspensions irradiated under conditions of oxygen deficiency (O_2 concentration < 1 μM O_2/l.). Approximately the same sensitizing effect was found on irradiating the cells at −78°C. At −196°C the effect of KCN was much smaller (dose-reducing factor = 0.85). The presence of a small amount of oxygen, not consumed as a result of inhibition of respiratory enzymes by cyanide is regarded as the most feasible explanation of the effect of KCN on the radiosensitivity of the cells. The possible origin of this small amount of O_2 is discussed, with reference to whether it might come from hydrogen peroxide formed by radiolysis of water during irradiation. (auth)

5722 TRANSPLANTATION OF VARIOUS NUMBERS OF FOREIGN BONE-MARROW CELLS IN MICE AFTER LETHAL AND SUPRALETHAL X-IRRADIATION. O. Vos (RVO-TNO, Rijswijk, Netherlands). Intern. J. Radiation Biol., 8: 21-33(1964).

Survival of irradiated mice treated with sub-optimal numbers of allogeneic bone-marrow cells could not be improved by addition of a large number of bone-marrow cells derived from the same donor strain and made incapable of proliferation by irradiation with 3000 R. This argues against the absorption of natural antibodies by excess of antigen. Survival-curves of mice treated with sub-optimal numbers of allogeneic bone-marrow cells showed the greatest mortality in the period of 10 to 20 days after lethal irradiation. This mortality was diminished if the hosts were irradiated with supralethal x ray doses. In the combinations studied the number of required allogeneic or rat marrow cells was decreased after supralethal irradiation of the recipients. Determinations of the number of nucleated cells present in bone-marrow and spleen showed a continuous increase in lethally-irradiated mice treated with syngeneic cells and in supralethally-irradiated mice treated with allogeneic cells. In lethally-irradiated mice treated with allogeneic bone-marrow cells, this increase was interrupted at about 14 days after irradiation by a small transitory remission. These data were explained on the basis of an active immunological response after an extended induction period in lethally-irradiated mice treated with foreign cells. After supralethal irradiation this residual response is depressed. Stimulation of the phagocytic activity of the RES through zymosan injections did not decrease survival of lethally- and supralethally-irradiated mice that were treated with allogeneic or rat bone-marrow suspensions. Instead there was a tendency toward a beneficial effect on survival. (auth)

5723 SPECTROPHOTOMETRIC EFFECT OF SALICYLIC ANTIRADIATION AGENTS ON CATALASE AND LACTIC DEHYDROGENASE. William O. Foye and Philip S. Thibodeau (Massachusetts Coll. of Pharmacy, Boston). J. Pharm. Sci., 53: 1150-3(Oct. 1964).

Spectrophotometric measurements were made of systems of catalase and of lactic dehydrogenase containing either salicylic acid, 2-mercaptoethylamine, 2-mercaptoethylguanidine, or sodium diethyldithiocarbamate. Absorption differences indicated complex formation between the dithiocarbamate and lactic dehydrogenase and at least salt formation with catalase. No definite indication of complex formation between these enzymes and either salicylic acid or the basic mercaptans was given by the method employed, although salt or weak field complex formation is a possibility with the latter. (auth)

5724 PROBLEMS IN TRANSPLANATION OF BONE MARROW. Jan Sablinski (Inst. of Nuclear Research, Warsaw). Polskie Arch. Med. Wewnetrznej, 32: 809-18(1962). (In Polish)

Experiments are reviewed which show that the injection of blood-producing cells is effective in lowering the death rate of animals subjected to large doses of radiation. Originally it was thought that the protective effect was due to factors which stimulated blood production or to a substance which protected against toxic compounds induced by radiation. Various marking methods were used to identify the injected marrow cells and to trace their proliferation in the hematopoietic tissues of the recipient, replacing the cells destroyed by radiation. Experiments with mice, rats, rabbits, dogs, and monkeys are described. Within a few days after grafting the red and white blood cells of the donor were observed in the bloodstream of the recipient, and the number of these cells may increase within a few weeks' time to such a degree that in some animals there are more blood cells of the donor than of the recipient mal. The fundamental immunologic problems encountered in transplantation of marrow tissue are reviewed, and it is pointed out that compatibility of blood types between the donor and the recipient is not sufficient to ensure successful grafts of hematopoietic tissue. (BBB)

Radiation Hazards and Protection

5725 (UR-653) HAZARD TO MAN FROM I-131 IN THE ENVIRONMENT. Richard George Cuddihy (Roch-

ester, N. Y. Univ. Atomic Energy Project). Oct. 1, 1964. Contract W-7401-eng-49. 61p. Dep.; $3.00(cy), 2(mn) OTS.

The major factors involved in the transfer of ^{131}I from the environment into the body of man, and in addition, its sources, deposition of its energy in the body, and methods which may be employed to minimize the radiation hazard, are described. An experiment on man is described and data from the literature are introduced where pertinent. The survey of the experimental data in the literature shows a large area of agreement with minor uncertainties. The practicality and usefulness of potentially hazardous sources of radioactive materials make their continued employment likely. The best protection against injuriously high environmental radioactivity remains the intelligent management of its production. Unintended releases of these materials can be rendered less harmful by intelligent manipulation of our biological environment. An exploration is made of means at hand to effect such environmental control. 55 references. (auth)

Radiotherapy and Radiodiagnosis

5726 (JUL-194-ST) ISODOSEN DER Cs-BESTRAHLUNGSANLAGE DER KFA JULICH (PROBLEME DER TIEFENSTRAHLENTHERAPIE). (Isodoses for the Cs Irradiation Facility of the KFA, Julich (Problems of Deep Irradiation Therapy)). K. Kasperek and H. G. Schnipperling (Kernforschungsanlage, Julich, Germany). Sept. 1964. 32p. Dep.(mn).

Isodoses of the Cs irradiation installation of the Julich KFA were measured in a water phantom and are presented graphically in the horizontal plane. (M.C.G.)

5727 (ANL-Trans-113) THE SIGNIFICANCE OF THE RBE FOR THE RADIATION THERAPY. H. Gaertner. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Biophysik, 1: 214-15(1964). 3p. Dep.(mn); $1.10(fs), $0.80(mf) JCL.

There exist many problems concerning the evaluation and the practical applicability of the experimental RBE-values which remain still open for the clinician. The numerous available single determinations of the RBE on diversified biological objects provide important clues for the tumor therapy. These directional values have undoubtedly facilitated the quantitative comparison with the conventional therapy and have contributed to a successful application of new radiation qualities. They can be applied, however, only in conjunction with the radiation-therapeutical experience of the clinician. The conditions are still such that also with respect to the RBE only the number of recoveries will provide the final decision concerning the success or failure of the kind of therapy. Some experimental data from the diversified field of the radiation-induced cell damage are used as examples in order to point out physical and biological factors of importance for the evaluation and classification of the RBE at the cellular level. These characterize in general the effect of the dose, dose capacity, and radiation quality upon the radiation-induced lethal damage of the tumor cells. The RBE-values were determined mainly by the applied test criteria and can therefore be only of a general directional significance and can by no means bridge from the radiation biological experiment to the tumor therapy. (auth)

5728 ON SPECIALIZED TRAINING IN THE AREA OF RADIOLOGY AND RADIATION MEDICAL SCIENCE. Friedrich E. Stieve (Universität, Munich). Aerztl. Forsch., 17: 275-82(May 10, 1963). (In German)

In order to improve training in the field of radiology in Germany the time required and the material presented should be increased and diversified. Preparation for this field of study should include diagnostic methods, such as tomography, kymography, and angiography, anatomy, general pathology, physiology, and pathological physiology. If available, training in biology and physics is desirable. For successful practical training basic theoretical knowledge is required from the areas of radiation physics, dosimetry, basic fundamentals of mathematics and biological statistics, radiobiology, including genetics, radiation pathology, x-ray anatomy, instrumentation techniques, and radiation protection. Many textbooks that are published in these fields assume that the reader has greater knowledge of the basic physics required than is often the case. The requirements for practical training places a heavy responsibility on clinical applications in the field of radiology. X-ray diagnostic training should include the fields of internal medicine, surgery, urology, neurology, pediatrics, ophthamology, otolaryngology, and gynecology. In order to cover all of the areas in which a radiologist should be trained, it is estimated that almost five yr would be required. This would include x ray diagnosis, 24 months, radiation therapy, 18 months, clinical practice and nuclear medicine, 6 months each, and education in radiation protection, dosimetry, and application of radioisotopes, 4 months. In addition, this training should be supplemented with clinical-pathological demonstrations, presentation of important clinical cases, special lectures in diagnosis and therapy, colloquia in actual problems of radiology and active participation in teaching and scientific studies. (BBB)

5729 ERYTHEMA IN AREAS OF PREVIOUS IRRADIATION IN PATIENTS TREATED WITH HYDROXYUREA (NSC-32065). M. E. Sears (Univ. of Texas, Houston). Cancer Chemotherapy Rpts., No. 40, 31-2(Aug. 1964).

Three patients are described who apparently had augmentation of irradiation erythema produced by hydroxyurea. This is either a rare finding or has not been specifically sought. In the future, hydroxyurea-treated patients should be observed for this phenomenon to determine whether there may be a synergistic effect of the drug and radiotherapy. (auth)

5730 THE USE OF RADIOACTIVE TRIIODOTHYRONINE FOR IN VITRO DIAGNOSIS OF THYROID FUNCTION. F. A. Horster and E. Klein (Medizinische Akademie, Duesseldorf). Deut. Med. Wochschr., 89: 983-6(May 14, 1964). (In German)

From a series of 370 in vitro studies of the binding of radioactive triiodothyronine-^{131}I by serum globulin, as measured with the aid of an ion exchanger, binding in 243 indicated euthyroid status. Concurrent diagnosis of the patients by other methods indicated that only 168 of these cases studied were actually euthyroid. Of 101 tests that indicated hyperthyroid states, 97 were ultimately diagnosed to be hyperthyroid, and 19 out of 26 patients with in vitro hypothyroid results were finally diagnosed as clinically hypothyroid. Out of the total number of tests, 76 could not be assigned definitely to any of the three groups. In all, ~65% of the thyroid malfunctions were correctly diagnosed by supplemental tests, but with the in vitro test the false diagnostic results were reduced to ~10%. A combination of the ^{131}I thyroid uptake test and measurement of trichloroacetic acid precipitable ^{131}I resulted in ~90% diagnostic accuracy. This could be increased to ~100% when hormonal iodine was also determined. Certain physiological or disease states that may accompany thyroid disorders can influence the in vitro triiodothyronine test, resulting in inaccuracies. The test values are elevated in pulmonary insufficiency, cardiac insufficiency, cirrhotic hepatitis, carcinomatous metastases, and nephrosis. During pregnancy and menstruation the test values obtained are decreased below the normal level. (BBB)

5731 FRACTIONAL EXPOSURE RATE DUE TO SCATTERED RADIATION FROM A Co^{60} TELETHERAPY UNIT. W. H. Henry and C. Garrett (National Research Council, Ottawa). Intern. J. Appl. Radiation Isotopes, 15: 544-5(Sept. 1964).

Measurements were made of the fractional exposure rate due to photons scattered by the material of the teletherapy head but excluding photons scattered within the source itself. Comparisons were made of exposure rates measured with an ionization chamber at a fixed distance from a source, first with the source bare, and then with the source mounted in the teletherapy head. The fractional exposure rate was then calculated. (M.C.G.)

5732 DIGITAL COMPUTER ANALYSIS AND DISPLAY OF THE RADIOISOTOPE SCAN. Donald W. Brown (Univ. of Colorado, Denver). J. Nucl. Med., 5: 802-6(Oct. 1964).

A method of approaching the analysis of the radioisotope scan objectively using statistical testing with a digital computer is under development. Pulses from the pulse height analyzer of the scanner are summated at one second intervals and fed into a computer. By this means, variation in activity from adjacent areas can be evaluated for statistical significance. The computer's printer can then be used to print out scans graphically allowing one to vary the background erase and contrast enhancement. Lesions can sometimes be clearly demonstrated by this technique when they can only be suspected on ordinary scans. (auth)

5733 RADIOISOTOPE RENOGRAM IN KIDNEY TRANSPLANTS. Merle K. Loken, Edward V. Staab, Robert L. Vernier, and William D. Kelly (Univ. of Minnesota, Minneapolis). J. Nucl. Med., 5: 807-10(Oct. 1964).

A brief case history of a patient who was considered as a candidate for transplantation because of renal failure secondary to chronic glomerulonephritis is described. The patient received two cadaver kidneys. Abnormal patterns were obtained at various times following kidney transplants. Delayed excretory phase with a gradual depression of the functional peak was the most consistent pattern seen during a rejection reaction. The interpretation of the renogram pattern did not always correlate with the clinical status. In some cases an abnormal pattern persisted despite an improvement in urine output and blood chemistries. (P.C.H.)

5734 • PROPERTIES, USES, RADIOCHEMICAL PURITY AND CALIBRATION OF Tc^{99m}. E. M. Smith (National Institutes of Health, Bethesda, Md.). J. Nucl. Med., 5: 871-82(Nov. 1964).

The properties and uses of ^{99m}Tc are discussed. From experience to date, the radiochemical purity of ^{99m}Tc from the ^{99m}Tc generator is comparable with other radiopharmaceuticals currently available. Scintillation spectrometry should be used initially to calibrate ^{99m}Tc. Ionization chamber calibration techniques may be used once the ionization chamber has been cross-calibrated against the scintillation spectrometry technique. At present only four to six institutions are using ^{99m}Tc. This number will increase rapidly, especially as this element's chemical characteristics are taken advantage of to direct its uptake and movement throughout the body. (auth)

5735 CLINICAL EXPERIENCES WITH CONTACT ROENTGEN RADIATION OF LARGE FIELDS. Eugene F. Lutterbeck (Northwestern Univ., Chicago). Medicamundi, 10: No. 1, 22-7(1964).

The use of large field contact therapy in treating 1712 benign and malignant tumors in 867 patients is reported. A special nylon grid was employed to achieve homogeneous irradiation. The method, previously reported, was found to be of greatest value in radiotherapy of keloids, hemangiomas, and malignant tumors of the skin. (H.M.G.)

5736 CLINICAL STUDY IN THE RADIOISOTOPE RENOGRAM. T. Minami, T. Machida, A. Ishibashi, and M. Miki (Jikei Univ., Tokyo). Radioisotopes (Tokyo), 13: 404-10(Sept. 1964). (In Japanese)

Suitable tracing conditions for renographic equipment can be determined when the normal renogram becomes equal to that of the standard pattern. Suitable tracing conditions for the equipment described are: scintillator NaI(1 in. $\phi \times 1$ in.), collimator wide-field, resolving power of ratemeter less than 25 μs, range 1×10^4 cpm, time constant 10 sec, effective breadth of recording paper 18 cm, recording speed 10 mm/min, test agent ^{131}I-hippuran, dose 4 $\mu C/10$ kg, and patient position upright. Renograms of 44 kidneys of 22 normal males were analyzed and a standard value of each interpreting element was established. They are as follows: A-time 30 sec, point-A 3,000 ~ 5,000 cpm, point-B 5,000 ~ 8,000 cpm, B-time 2 min 30 sec or less, point-B (cpm)/point-A (cpm) = 1.5 ~ 1.7, and the half count time to point-B on segment-c 5 min or less. After a study of numerous patients having normal, diseased, or non-functional kidneys, the renogram was classified into four patterns. The relationship between renogram and PSP test was studied on 80 patients with solitary kidney. The patterns observed are described. The relationship between RPF and segment b or point A was studied on 40 patients, and considerable correlation was noticed. It is believed that the best way to know the renal function from renogram is to classify it to one of the four patterns at first, and then measure the interpreting elements, compare them to the normal value, and to that of the contralateral kidney. (P.C.H.)

5737 RECENT ADVANCES IN RADIOLOGY. Fourth Edition. Thomas Lodge, ed. Boston, Little, Brown and Company, 1964. 352p.

Selected topics of radiology are discussed by experts in the particular field. The topics discussed include the dose from diagnostic x ray procedures; the cardio-vascular system; complications of gastric resection; the small intestine; the liver, spleen, gall bladder, and pancreas; the urinary tract; cysto-erethrography; the radiology of metabolic bone disease; fractures of the face; diseases of the chest, and the central nervous system. A separate abstract was prepared on the first topic discussed. (C.H.)

For an abstract of individual paper see: 5738.

5738 THE DOSE FROM DIAGNOSTIC X-RAY PROCEDURES. G. M. Ardran and H. E. Crooks. p.1-23 of "Recent Advances in Radiology. Fourth Edition." Boston, Little, Brown and Company, 1964.

The radiation protection of both patients and operators during diagnostic x ray procedures is discussed. Results are summarized from surveys of the radiation dose to the population from diagnostic procedures, and procedures are outlined for ensuring that diagnostic radiography is performed with the minimum dose to both patient and operator. Topics emphasized include education and discipline, reduction of radiation leaks, the reduction of off-focus radiation, collimation of the beam, the use of filters, absorption of secondary radiation, image intensification and fluoroscopy, the use of grids, kilovoltage selection, optimum film focus distances, optimum processing, and radiation dose to the operator and patient. (C.H.)

5739 SCINTILLATION SCANNING IN CLINICAL MEDICINE. Based on a Symposium [held at Winston-Salem, N. C., January 30 and 31, 1964]. James L. Quinn, III, ed. Philadelphia, W. B. Saunders Company, 1964. 285p. (CONF-640101)

Eighteen papers were presented: separate abstracts have been prepared for each. A panel discussion on brain scanning was not abstracted. (H.M.G.)

For abstracts of individual papers see: 5740, 5741, 5742, 5743, 5744, 5745, 5746, 5747, 5748, 5749, 5750, 5751, 5752, 5753, 5754, 5755, 5756, and 5757.

5740 CERTAIN FUNDAMENTAL PHYSICAL CONSIDERATIONS IN SCANNING. C. Craig Harris (Oak Ridge National Lab., Tenn.) p.1-15 of "Scintillation Scanning in Clinical Medicine." Philadelphia, W. B. Saunders Company, 1964.

An attempt is made to show the inexperienced scanning investigator that some time in study of this part of the scanning system might well lead to much improved clinical results. It has also been found to be generally true that clinical scanning starts off stronger when it is preceded by practice and experimentation with phantom sources. Study of the references, both general and specific, and thorough familiarity with the properties of one's scanner are heartily recommended to those entering scanning. (auth)

5741 PHARMACOLOGICAL PRINCIPLES IN THE DEVELOPMENT OF RADIOPHARMACEUTICALS FOR RADIOISOTOPE SCANNING. Henry N. Wagner, Jr. (Johns Hopkins Univ., Baltimore). p.16-29 of "Scintillation Scanning in Clinical Medicine." Philadelphia, W. B. Saunders Company, 1964.

Principles on which the development of new radiopharmaceuticals for scanning may be based are discussed under the following classifications: pharmaceutical, physiological, technological, and radiation safety. Advantages and disadvantages of specific radiopharmaceuticals are presented for radioisotope scanning of thyroid, kidneys, liver, spleen, and brain. (H.M.G.)

5742 THE USE OF PHANTOMS IN DEVELOPING AND REFINING SCINTILLATION SCAN PROCEDURES. John U. Hidalgo (Tulane Univ., New Orleans). p.30-42 of "Scintillation Scanning in Clinical Medicine." Philadelphia, W. B. Saunders Company, 1964.

The application of two simple phantoms is described. It is believed that these illustrate a set of conditions that will be of considerable value to the scan operator in establishing criteria for scanning with the equipment in use. (auth)

5743 APPLICATION OF SCINTILLATION SCANNING IN THYROID DISEASE. J. Martin Miller (Henry Ford Hospital, Detroit). p.43-54 of "Scintillation Scanning in Clinical Medicine." Philadelphia, W. B. Saunders Company, 1964.

The thyroid scintigram is of value in the study of the patient with suspicious thyroid nodules, nonsuppressible ^{131}I uptakes, and suspected or proved thyroid malignancy. It has made a significant contribution to our knowledge of thyroid physiology, and further uses in the investigative field should be anticipated. The eventual contribution of the thyroid scintigram will be determined not by resolution of the phantom nodule, but by its aid in patient care; not by the specialist in nuclear medicine, but by the specialist in treatment of people with thyroid disease. (auth)

5744 PARATHYROID SCANNING. William H. Beierwaltes, Walter Di Giulio, and James C. Sisson (Univ. of Michigan, Ann Arbor). p.55-68 of "Scintillation Scanning in Clinical Medicine." Philadelphia, W. B. Saunders Company, 1964.

Efforts to locate hyperfunctioning parathyroid glands in dogs and humans by photoscanning techniques are summarized. Cobalt-57-labeled vitamin B_{12} and ^{75}Se-labeled-methionine were used. It was concluded that ^{57}Co-B_{12} showed sufficient relative concentration in the parathyroid to make it theoretically possible to find parathyroid adenoma over 1 gm in size outside the thyroid gland area. However, the specific activity of present preparation makes this technique impractical. Similarly, ^{75}Se-methionine concentrations are sufficient for diagnosis, but present preparations were unreliably impure. (H.M.G.)

5745 THE DETECTION OF BONE METASTASES BY PHOTOSCANNING WITH RADIOACTIVE STRONTIUM. David M. Sklaroff and N. David Charkes (Albert Einstein Medical Center, Philadelphia). p.69-86 of "Scintillation Scanning in Clinical Medicine." Philadelphia, W. B. Saunders Company, 1964.

The use of ^{85}Sr and ^{87m}Sr in photoscanning bones for the detection of metastatic tumor in patients with known cancer is reported. The technique is capable of detecting metastases prior to observable roentgenographic changes, as proved by bone biopsies in four patients in this series. In 28 patients the scan was positive, and the x-ray negative. In four cases, the reverse was true, usually because of the presence of a highly undifferentiated, rapidly proliferating tumor such as reticulum cell sarcoma. Phantom studies and clinical correlation have established the validity of the method insofar as resolution is concerned. Not only has this technique been of value in diagnosis of occult bone disease, but it has enabled the radiation therapist to plan his treatment portals more effectively, since it gives a better delineation of the extent of the disease process. A newer isotope of strontium, ^{87m}Sr, appears to add additional avenues to this approach to the diagnosis of bone metastasis by means of photoscanning with radioactive isotopes. (auth)

5746 PANCREAS SCANNING WITH Se^{75} L-SELENOMETHIONINE. Merrill A. Bender and Monte Blau (Roswell Park Memorial Inst., Buffalo). p.87-92 of "Scintillation Scanning in Clinical Medicine." Philadelphia, W. B. Saunders Company, 1964.

Advantages of using ^{75}Se-L-selenomethionine for pancreas scanning are discussed, and scanning procedures are presented. A current program for evaluating the clinical usefulness of pancreas scanning is described. (H.M.G.)

5747 THE DEVELOPMENT OF MYOCARDIAL SCANNING WITH SPECIAL REFERENCE TO THE USE OF CESIUM-131 IN MAN. Edward A. Carr (Univ. of Michigan, Ann Arbor). p.93-103 of "Scintillation Scanning in Clinical Medicine." Philadelphia, W. B. Saunders Company, 1964.

Rubidium-86 chloride, chlormerodrin labeled with radioactive mercury, and salts of ^{131}Cs were investigated in dogs and man with a view to developing a technique that permits the visualization of the myocardium by scanning. The most successful technique employs salts of ^{131}Cs. With this isotope myocardial infarcts in living man was demonstrated without discomfort to the patient. The future possibilities of myocardial scanning are briefly discussed. (auth)

5748 HEART POOL SCANNING. David M. Sklaroff and N. David Charkes (Albert Einstein Medical Center, Philadelphia). p.104-13 of "Scintillation Scanning in Clinical Medicine." Philadelphia, W. B. Saunders Company, 1964.

Radioisotope scanning is a safe, simple, and useful method for the diagnosis of pericardial effusion and aortic aneurysm. The whole body radiation dose from ^{131}I iodipamide is no greater than the dose received from a standard posteroanterior chest roentgenogram or a blood volume determination. There are no side effects or complications from the procedure, and it is well tolerated by the patient. The scan can be repeated at intervals to assess progress of the disease or response to treatment. Cardiovascular scanning with radioactive isotopes can be recommended as a useful and safe diagnostic tool. (auth)

5749 SELECTIVE NEOPLASM LOCALIZATION WITH MERCURY-197 CHLORMERODRIN. D. Bruce Sodee (Renner Clinic Foundation and Doctors Hospital, Cleveland) and Doris Clifton. p.114-24 of "Scintillation Scanning in Clinical Medicine." Philadelphia, W. B. Saunders Company, 1964.

Preliminary clinical work describing the accumulation of ^{197}Hg chlormerodrin in tumors is presented. Accumulation was found in all tumors except that in those organs in which mercury is normally concentrated, this ability is lost with carcinomatous change. Granulomas, probably because of their areas of necrosis, also have a high mercury accumulation. (auth)

5750 DIAGNOSIS OF MASSIVE PULMONARY EMBOLISM IN MAN BY RADIOISOTOPE SCANNING. Henry N. Wagner, Jr., David C. Sabiston, Jr., John G. McAfee, and Donald E. Tow (Johns Hopkins Univ., Baltimore). p.125-41 of "Scintillation Scanning in Clinical Medicine." Philadelphia, W. B. Saunders Company, 1964.

Radioisotope scanning of the lungs in 110 patients and 90 dogs following the intravenous injection of ^{131}I or ^{51}Cr macroaggregated albumin (MAA) was a safe and effective way of diagnosing massive pulmonary embolism. In many patients a characteristic pattern of avascularity was observed. This consisted of a decreased pulmonary blood flow to all or part of the right lower lung field and to a crescent-shaped area on the lateral mid-portion of the left lung. To date, no hemodynamic, immunologic, or radiation hazard has been observed. The method has been found to be an important adjunct to selective pulmonary arteriography, and has important advantages in being readily available, faster, technically easier, and free of morbidity. Consequently it was used as a rapid screening procedure and made possible serial studies at frequent intervals in the same individual. The scanning technique was found to be particularly suitable for the evaluation of the natural history of massive pulmonary embolism, as well as in determination of the effectiveness of surgical

procedures, such as vena caval ligation, or of drugs, such as anticoagulants or fibrinolytic agents. (auth)

5751 LUNG SCINTISCANNING. James L. Quinn, III (Northwestern Univ., Chicago) and Joseph E. Whitley. p.142-62 of "Scintillation Scanning in Clinical Medicine." Philadelphia, W. B. Saunders Company, 1964.

A method of producing experimental pulmonary infarcts in dogs, and detecting them by a scintiscan technique employing aggregates of ^{131}I tagged human serum albumin is presented. The clinical application of this diagnostic test in the detection of pulmonary infarct is described and discussed. The application of this technique in evaluating other diseases of the chest is outlined. (auth)

5752 SPLEEN SCINTILLATION SCANNING. F. D. Pepper, Jr. (Univ. of North Carolina, Chapel Hill). p.163-77 of "Scintillation Scanning in Clinical Medicine." Philadelphia, W. B. Saunders Company, 1964.

In spite of the fact that the spleen, unlike the thyroid, liver, or kidneys, is infrequently involved by conditions that would make visualization of its outline and internal structure of paramount diagnostic value, splenic scintiscanning still remains a valuable adjunct to the modern diagnostic armamentarium. Four methods have been presented, two of which are of proven usefulness; the other two, of more recent vintage, need further clinical trial. The lack of other simple and readily available procedures for evaluating the spleen has likewise accentuated the importance of the examination. Categories of indications consist of obscure left upper quadrant abdominal masses, the qualitation and quantitation of splenomegaly, the question of space-occupying lesions within the spleen, and the detection of asplenism or the presence of normal or accessory functioning splenic tissue. Radiation exposure appears to be within acceptable limits. (auth)

5753 LIVER SCANNING. Merrill A. Bender (Roswell Park Memorial Inst., Buffalo). p.178-82 of "Scintillation Scanning in Clinical Medicine." Philadelphia, W. B. Saunders Company, 1964.

Advantages and disadvantages of liver scanning based on analysis of 548 scans are discussed. All patients received either colloidal ^{198}Au or ^{131}I rose bengal. (H.M.G.)

5754 THE VALUE AND LIMITATIONS OF SCINTILLATION SCANNING IN THE DIAGNOSIS OF INTRACRANIAL TUMORS. John G. McAfee and Gerhard F. Fueger (Johns Hopkins Univ., Baltimore). p.183-217 of "Scintillation Scanning in Clinical Medicine." Philadelphia, W. B. Saunders Company, 1964.

In its present state of development, radioisotope scanning is a valuable screening procedure for the detection for the detection of intracranial tumors. It is especially accurate for tumors of the cerebral hemispheres, and less accurate for tumors of the posterior fossa, midbrain, pituitary fossa, and intraventricular lesions. Slow-growing gliomas, particularly Grades I and II astrocytomas, are not infrequently missed by this technique. The procedure is completely free from the morbidity and mortality sometimes associated with cerebral angiography and air studies. As the technique is more widely used, it is becoming apparent that abnormal patterns are produced by a wide variety of focal organic lesions of the brain, and are not specific for tumors. The current limitations of this method are interrelated. Scanning procedures still require an excessively long time, particularly when three or four projections are obtained. In spite of the slow linear scanning speeds, the resolution of detection is due more to the statistical variations in count rate than to the optical resolution of the collimators. In this series of patients, ^{203}Hg chlormerodrin did not appear to be superior to ^{131}I albumin. Both have beta emissions and a relatively long effective half life; increasing the administered dose of these substances to improve the counting rate is therefore undesirable. In the future, these limitations will be overcome by the use of labeled substances with a short physical or biological half life administered in larger doses, by more efficient detectors, and by agents that localize more specifically in tumor tissues. (auth)

5755 CLINICAL APPLICATION OF RENAL SCANNING. Thomas P. Haynie (Univ. of Texas, Galveston), Bruce H. Stewart, and Donald M. Kurtz. p.231-44 of "Scintillation Scanning in Clinical Medicine." Philadelphia, W. B. Saunders Company, 1964.

After five years of clinical experience, the renal scan has taken a secure position as one of the more useful of current scanning procedures. It can be performed simply as a routine procedure and interpreted without resort to elaborate methods. It may permit ready diagnosis of renal tumors, renal vascular disease, congenital abnormalities, or renal parenchymal disease. It may give positive information when other diagnostic procedures are equivocal or negative. It is, of course, not 100 per cent effective in diagnosis, and it has limitations, both clinical and technical. It is hoped that future improvement of methods will remove some of these limitations. (auth)

5756 SCINTILLATION SCAN TECHNIQUES IN THE EVALUATION OF RENAL DISEASE. Joseph L. Izenstark (Emory Univ., Atlanta). p.245-57 of "Scintillation Scanning in Clinical Medicine." Philadelphia, W. B. Saunders Company, 1964.

Physicians interested in radioactive isotopes are well aware of the usefulness of organ scanning. However, many physicians, hospitals, institutions, and lay personnel still are not aware of this useful diagnostic procedure. It is to these groups that educational efforts must be directed. Organ scanning, particularly kidney scanning, has advanced rapidly, paralleling the development of scanning equipment. Mercury-197 scanning is an effective method of visualizing renal tubules with a low patient and kidney radiation dose. Techniques must be developed that can selectively and rapidly detect the appearance and function of glomeruli, tubules, and calyceal-pelvic structures. Indications for kidney scanning are the same as for the routine pyelogram. The kidney scan is a safe procedure, complementing the pyelogram, and can spare the patient additional pyelograms or retrograde examination. In selected cases it has been extremely useful in helping urologists plan the patient's management. (auth)

5757 DEVELOPMENT AND FUTURE OF SCINTILLATION SCANNING. William H. Beierwaltes (Univ. of Michigan, Ann Arbor). p.258-67 of "Scintillation Scanning in Clinical Medicine." Philadelphia, W. B. Saunders Company, 1964.

Historical development and present status of scintillation scanning are reviewed requisite to a discussion of the future course of the technique. It is suggested that the successful union of present and new instrumentation, new radioisotope-labeled compounds, and new ideas will make the future of scintillation scanning a promising era in diagnostic organ scanning, quantitation of flow, and the diagnosis and treatment of cancer. (H.M.G.)

CHEMISTRY

General

5758 (AAEC/TM-261) APPARATUS FOR HELIUM PURIFICATION AND MEASUREMENT. D. Kairaitis (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Oct. 1964. 10p. Dep.(mn).

An all-glass, high-vacuum apparatus for the purification and measurement of helium in the range 10^{-2} to 10^{-5} cm^3 is described. The apparatus was developed for the determination of the diffusion constants for helium in irradiated beryllium oxide. Tests of the efficiency of purification procedures showed complete recovery of helium from samples. (auth)

5759 (NP-14263) LOS HALUROS DE PLATA COMO AGENTES SECUESTRANTES DEL ION RADIOIODURO. Informe No. 116. (Silver Halides as Absorption Agents of Radioiodine. Report No. 116). Leopoldo Jose Anghileri (Argentina. Comisión Nacional de Energía Atómica, Buenos Aires). 1964. 9p. Dep.(mn).

The behavior of silver iodide and chloride as absorption agents for radioiodine was studied in dependence on the concentration of KI carrier, concentration of NaCl, presence of various concentrations of gelatine, pH, and temperature. The absorptive capacity of AgI_2 has its maximum with 10^{-4} M of KI carrier, but the chloride has its maximum at 10^{-3} M carrier. Both decrease rapidly after the maxima is passed. At a concentration of 0.5 M NaCl, the absorptive properties of the $AgCl_2$, decreases sharply, but the AgI_2 has a maximum. The absorptive properties of both decrease slightly with increase in concentration of gelatine, but increase with temperature. With increasing pH there is a slight decrease for both the iodide and chloride. These results are discussed. (J.S.R.)

5760 (ORNL-TM-1012) AN ANNOTATED BIBLIOGRAPHY ON HIGH TEMPERATURE AND HIGH PRESSURE CHEMICAL RESEARCH. D. M. Helton and W. D. Bond (Oak Ridge National Lab., Tenn.). Dec. 14, 1964. Contract [W-7405-eng-26]. 43p. Dep.(mn); $2.00(cy), 1(mn) OTS.

This bibliography of 142 references was compiled primarily from a search of Chemical Abstracts and Nuclear Science Abstracts through April, 1964. The bibliography is limited to studies of high temperature and/or pressure which appeared to be applicable to the area of Chemical Applications of Nuclear Explosions. The annotations give the method of producing high temperature or pressure, the range of temperature or pressure achieved, and the chemical system studied. The entries are cross-referenced, and indexes of authors and subjects investigated are included. (auth)

5761 (TID-21344) [CHEMICAL SAFETY GUIDES]. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Revised Mar. 7, 1963. Contract [AT(45-1)-1350]. 115p. Dep.(mn); $4.00(cy), 2(mn) OTS.

This manual presents pertinent information on the health and safety aspects of inorganic and organic chemicals. The information includes properties, hazards, and emergency procedures. (D.L.C.)

5762 (WAPD-Trans-2) INVESTIGATION OF THE DISSOLVING ACTION OF COMPLEXING AGENTS ON BOILER DEPOSITS. A. P. Mamet and E. F. Vlasova. Translated from Teploenergetika, 9: No. 11, 69-74(1962). 12p. Dep.(mn); $1.00(cy), 1(mn) OTS; $1.60(fs), $0.80(mf) JCL.

Organic complexing agents can be used to remove deposits from steam boilers and have considerable advantages over the hydrochloric acid currently used for this purpose. The most effective agents are ethylenediaminetetraacetic acid (EDTA), versene, and ammonium monocitrate. In some cases these may be replaced by appropriate production wastes. The applicability of Trilon A is yet to be determined. An obstacle to the widespread use of these reagents at present (in addition to the need for production studies) is the high cost and small-scale production. There exist prospects for increasing the output and reducing the cost of these reagents to an acceptable level of the order of 1-2 rubles/kg. The aggressiveness of complexing agents with respect to steel is only a very small fraction of the aggressiveness of HCl. Corrosion is mainly uniform in character, without distinct pitting of surface. After treatment with complexing agents, the metal surface does not rust in air for a long time. (auth)

5763 NOBLE GAS COMPOUNDS. N. Booth. Chem. Ind. (London), 29: 1305-6(July 1964).

Hydrates of Ar, Kr, and Xe were prepared with decomposition temperatures of −42.8, −27.8, and −3.4°C at one atm. No hydrates of He or Ne were prepared. Clathrates of Ar, Kr, and Xe in β hydroquinone were obtained under pressures up to 20 atm. Usually 75 to 80% of the available cavities were filled with the inert gas. In the case of phenols, clathrates were obtained with Ar, Kr, and Xe and not with He and Ne. There exist now about 20 compounds prepared mainly from Xe, particularly fluorides, oxides, oxyfluorides, and metal fluorides. In addition, two fluorides of Kr and one of Rn have been prepared. No chemical compounds of Ar, Ne, or He have yet been reported and it seems unlikely that they could be made using existing techniques. There are a number of possible uses for these compounds on a modest scale. However, unless uses are found which are of extraordinary value, it would not be practical to produce large amounts of the noble gases because of cost. (BBB)

5764 ADSORPTION OF DYESTUFFS BY HYDROUS THORIUM OXIDE: HEAT OF ADSORPTION OF THE DYES BY VARIOUS SAMPLES OF THE HYDROXIDE. Rameshwar Prasad and Arun K. Dey (Univ. of Allahabad, India). Kolloid Z., 183: 153-5(June 1962).

Experiments were conducted on adsorption of Congo red, an acidic dye, and fuchsin, a basic dye, by samples of hydrous thorium oxide precipitated by varying quantities of sodium hydroxide. The acid dye is adsorbed appreciably by samples precipitated with deficient alkali and the basic dye by samples obtained by an excess of alkali as precipitant. Thus the hydrous oxide is amphoteric in nature and its adsorptive capacities depend on its basic or acidic nature. Heats of adsorption of Congo red and fuchsin with various samples of hydrous thorium oxide at 25°, 40°, and 55°C were determined. For adsorption of the dyes by hydrous thorium oxide, samples A, B, C, and D of the hydrous oxide were prepared by adding calculated amounts of a standard solution of sodium hydroxide to 500 ml of 0.25M thorium chloride solution. The following samples were prepared: A, precipitated with 10% deficient NaOH; B, precipitated with equivalent NaOH; C, precipitated with 5% excess NaOH; and D, precipitated with 10% excess NaOH. Samples of these suspensions were equilibrated with solutions of the dyes for 24 hr and the dye remaining in solution was then estimated photometrically. The results obtained are tabulated according to the temperature and concentration of the dye. These values of heat of adsorption give a quantitative measure of the affinity of the hydroxides for the dye. For Congo red these values for the different samples varied according to the order: A > B > D > C. For fuchsin the order is: C > B > D > A. This order is similar to that in previous studies. (BBB)

Analytical Procedures

5765 (AAEC/TM-115) THE DETERMINATION OF PROTACTINIUM-233 IN SOLUTIONS FROM THE PRO-

CESSING OF IRRADIATED THORIUM ALLOYS. J. W. Morgan (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Dec. 1961. 14p. Dep.(mn).

A method is described for the radiochemical determination of protactinium-233. Interfering activities are removed by anion exchange and solvent extraction and recoveries are determined by adding protactinium-231. Absolute disintegration rates of protactinium-233 are estimated using a calibrated end-window beta counter. (auth)

5766 (AE-163) FLAME SPECTROPHOTOMETRIC DETERMINATION OF STRONTIUM IN WATER AND BIOLOGICAL MATERIAL. G. Joensson (Aktiebolaget Atomenergi, Stockholm). Oct. 1964. 17p. Dep.(mn).

A flame spectrophotometric method has been developed for the determination of strontium in biological material and water samples. Strontium is determined in the presence of calcium at a wavelength of 4607 A. The intensity of the strontium emission from the sample is increased if n-butanol is added to a solution of the sample in water. With a 6 vol % solution of n-butanol in water, an optimum intensity of 3.5 times that obtained with pure water solution is obtained. Anions and alkali metals which might interfere with the flame spectrophotometric determination are separated from the sample by a simple ion exchange operation. The method allows determination of strontium in solutions down to 0.1 μg/ml. In this case the standard deviation is 3.1% and with a strontium concentration of 1 μg/ml the deviation is 0.9%. This method has been used for the determination of strontium in samples of varying composition such as bone, meat, and skin from fishes, samples of human bones, shellfish, milk, and water, in which case Sr quantities of 5 μg were determined with an analytical error of less than 5% and Sr quantities greater than 10 μg with an error of less than 3%. (auth)

5767 (AWRE-O-88/64) THE DETERMINATION OF TRACES OF URANIUM BY DELAYED NEUTRON EMISSION. W. H. Davies and R. F. Coleman (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Nov. 1964. 12p. Dep.(mn).

A method is described for the rapid determination of traces of uranium by measuring the delayed neutron emission after fission. The sample, usually in 30 ml of solution, is irradiated for 1 min, allowed to cool for 25 sec, and counted for 1 min in an efficient boron trifluoride counter. A sensitivity of 7×10^{-9} g ^{238}U/liter can be obtained without concentrating the solution or performing chemical separations. The irradiated solution is removed from its container prior to counting to eliminate the effect of traces of uranium in the container and an apparatus for the rapid transference of the solution is described. (auth)

5768 (EUR-1886.f) BIBLIOGRAPHIE COMPAREE DE L'ANALYSE PAR ACTIVATION (RAPPORT FINAL). (Comparative Bibliography of Activation Analysis (Final Report)). (Société Atome Industriel, Paris). 1964. 288p. Dep.(mn).

A total of 500 examples of the applications of activation analysis are presented. The examples are in the form of standardized cards which include the matrix and reaction used, chemical procedures, interferences, etc. as well as the reference. (D.L.C.)

5769 (EUR-2168.e) MICRODETERMINATION OF TERPHENYLS BY SPECTROPHOTOFLUORIMETRY: ITS EXTENSION TO BIOLOGICAL MATERIALS. P. Scoppa and K. Gerbaulet (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1964. 44p. Dep.(mn).

The application of spectrophotofluorimetry to the quantitative determination of meta- and para-terphenyl is described. The fluorescent characteristics of pure and commercially available terphenyls are reported and discussed. A method is proposed for the assay of low concentrations of terphenyls; its application to biological materials is examined in detail. (auth)

5770 (GEAP-4540) SODIUM MASS TRANSFER. XIII. THE DETERMINATION OF TOTAL CARBON IN SODIUM. W. W. Sabol, D. Dutina, D. E. Rey, and J. L. Simpson (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). June 1964. Contract AT(04-3)-189. 24p. Dep(mn); $1.00(cy), 1(mn) OTS.

A modification of the classical Pepkowitz-Porter method for determining the carbon content in sodium has been made. In the new approach, carbon-containing gases released during dissolution of the sodium (gases that were discarded in the original work) are collected and are added to the CO_2 found by the customary wet oxidation. Improvements in preparing the Van Slyke oxidant have reduced the blank by a factor of 2.5. The sensitivity is 10 ± 5 ppm C with sample sizes ranging from 1.5 to 8.0 grams. All manipulations are performed in a closed system which eliminates the need for sweep or carrier gases and reduces the possibility of introducing contamination. Gas chromatography is used to determine the quantity of carbon evolved as CO_2 or other gaseous forms during the analysis. Results of analyses of samples removed from sodium mass transfer loops are presented. The technique established for collecting and identifying the components of the gas mixture released during the main steps in the procedure has provided evidence for the presence of more than one type of carbon (i.e., elemental) in the sodium. (auth)

5771 (HW-83474) URANIUM DETECTION BY X-RAY ANALYSIS. R. B. Jacob (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 1964. Contract AT(45-1)-1350. 27p. Dep.; $2.00(OTS).

A prototype x-ray fluorescent tester for detecting uranium contamination in nuclear fuel elements has been constructed. The tester uses an industrial type 150 kv x-ray machine as a source of radiation. The x-ray tube is mounted on a table in a manner that will allow the beam to illuminate the fuel element end. Shielding apparatus for the x-ray tube, and transport equipment for the fuel element, are also mounted on this table. A pair of single channel analyzers and recorders comprise the remaining items in the tester. The apparatus has a detection sensitivity of approximately 0.5 wt % uranium in a volume of 0.25×10^{-3} in.^{3} The scan speed for this sensitivity is approximately 5 in./min. A number of fuel ends have been tested and the results compared with data from autoradiograph and other tests. (auth)

5772 (IA-933) RAPID AND NON-DESTRUCTIVE ANALYSIS OF SULFUR AND CALCIUM BY RADIOACTIVATION AND PHOTONEUTRON COUNTING. S. Amiel and J. O. Juliano (Israel. Atomic Energy Commission. Soreq Research Establishment, Rehovoth). May 1964. 24p. Dep.(mn).

A method is described for the activation analysis of sulfur and calcium by the assay of 5.1-min sulfur-37 and 8.8-min calcium-49, using photoneutron counting. Both sulfur-37 and calcium-49, formed by neutron capture in sulfur and calcium respectively, decay with the emission of high energy (>3 Mev) gamma rays which cause emission of photoneutrons from a D_2O reservoir incorporated in a neutron counting assembly. The photoneutron activity is proportional to the content of the sulfur-37 or calcium-49 in the sample, the activity being ~20 cpm per mg sulfur and ~1100 cpm per mg calcium, when the sample is irradiated to saturation at a flux of 10^{13} neutrons/cm^2-second. Sensitivities of ~0.5 mg for sulfur and ~10 μg for calcium were obtained. Sulfur and calcium in samples containing various proportions of these elements were analyzed with satisfactory precision. The use of the method for the rapid determination of sulfur and calcium in complex matrices, without any chemical processing and by a simple and versatile apparatus, is discussed. (auth)

5773 (LA-3133) THE SPECTROPHOTOMETRIC DETERMINATION OF MICROGRAM QUANTITIES OF YTTRIUM IN TANTALUM. R. G. Bryan, G. R. Waterbury, and C. F. Metz (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. 12p. Dep.; $1.00(cy), 1(mn) OTS.

Trace concentrations (3 to 15 ppm) of yttrium in tantalum are separated by precipitation as yttrium trifluoride and determined spectrophotometrically as the Arsenazo I complex. A 5-gram sample of tantalum is dissolved in hydrofluoric and nitric acids, converting the yttrium to its insoluble trifluoride. This precipitate is separated by centrifuging and then converted to the soluble perchlorate salt in fuming nitric and perchloric acids. The yttrium complex is developed in a boric acid-Arsenazo I solution, and its absorbance is measured at 570 mμ. Relative standard deviations calculated from 14 or more determinations each of 14, 28, 42, and 71 μg of yttrium were 13, 5, 9, and 6 percent, respectively. Several metals, including calcium, lead, thorium, zirconium, and the lanthanides, interfere seriously in this method. The nonselectivity of this method limits its application to tantalum samples in which yttrium is the main impurity. (auth)

5774 (LA-3159) X-RAY FLUORESCENCE SPECTROMETRIC DETERMINATION OF URANIUM IN NIOBIUM TRICHLORIDE. E. A. Hakkila, R. G. Hurley, and G. R. Waterbury (Los Alamos Scientific Lab., N. Mex.). Sept. 1, 1964. Contract W-7405-eng-36. 17p. Dep.; $1.00(OTS).

An x-ray fluorescence spectrometric method was developed for determining 0.1 to 6% of uranium in niobium trichloride. Samples weighing approximately 500 mg are dissolved in nitric-hydrofluoric acids, bismuth is added to serve as an internal standard, and the solution is diluted to 10.00 ml with distilled water. The ratio of the intensities of the $L\alpha_1$ lines for uranium and bismuth is measured and compared to intensity ratios measured for solutions of known uranium content. The relative standard deviation of a single determination varies from 12 to 1.5% for uranium concentrations in the range between 0.1 and 6.0%. (auth)

5775 (RFP-419) THE DETERMINATION OF TRACE RESIDUES ON METAL SURFACES. J. L. Holst and D. K. Strangfeld (Dow Chemical Co. Rocky Flats Div., Golden, Colo.). Nov. 16, 1964. Contract AT(29-1)-1106. 28p. Dep.; $2.00(cy), 1(mn) OTS.

Analytical methods have been developed to characterize or identify residues removed from metal surfaces. The results are quantitative for several compounds such as, certain hydrocarbons, inorganic chlorides, water, and amine hydrochlorides. Solvents are used directly as surface rinsing agents or to rinse cold traps used on high vacuum cleaning systems. A method of determining water in halogenated solvents in the near infrared region is also reported. A unique method of drying the reference solvent using a water-solvent equilibrium is described. (auth)

5776 (SGAE-1B/IA-5/1964) DETERMINATION OF BORON IN STEEL BY NEUTRON ACTIVATION DEPRESSION. H. Spenke, T. Cless-Bernert, and B. Karlik (Österreichische Studiengesellschaft für Atomenergie G.m.b.H. Institut für Radiumforschung und Kernphysik, Vienna). [1960]. 7p. Dep.(mn).

A simple non-destructive method has been developed for determination of boron in steel by making use of the neutron flux depression due to ^{10}B. Using a calibration curve and comparing the activities of ^{59}Fe or other nuclei inside the boron steel sample and the boron-free steel sample, an accuracy better than 1% for the relative values can be obtained. (auth)

5777 (TID-20080) THE APPLICATION OF NUCLEAR TECHNIQUES IN COAL ANALYSIS. Annual Report No. 2. Troy C. Martin, Suresh C. Mathur, and Ira L. Morgan (Texas Nuclear Corp., Austin, Tex.). Dec. 1963. Contract AT(40-1)-2980. 112p. Dep.; $4.00(OTS).

The results of a feasibility study on the utilization of nuclear techniques in coal analysis showed that the C, O_2, Al, and Si contents can be accurately determined to within 1% to 3% under laboratory conditions. These results also indicate that to measure any of the other minor elements present in coal to the same degree of precision would be difficult and would require the use of radio-chemical separation techniques. The utilization of the nuclear techniques such as fast neutron inelastic scattering and fast neutron activation analysis depend upon the use of empirical relationships connecting the element or elements measured with the desired parameters. Measurements indicate that Btu and ash content may be empirically determined for coal from a particular mine through measurements by nuclear means. (auth)

5778 CONSIDERATIONS ON THE INVESTIGATION OF ARSENIC IN HAIR BY THE METHOD OF INDUCED RADIOACTIVITY. P. Savel (College de France, Paris). Ann. Pharm. Franc., 21: 303-8(Apr. 1963). (In French)

Neutron activation of samples of hair taken from a person poisoned by As has been used to deduce the periods of poison absorption; precise controls are necessary. The method is reviewed here; in equal amounts, As is detected most easily, followed by Na, Sb, and Br. The content of As in hair is low, and Na or P may be examined more easily. The precautions required for precise determinations in hair samples are outlined; the preparation and washing of samples are described. Quantitative data may be obtained by simultaneous irradiation of a standard containing a known amount of As. An apparatus for measuring activity is illustrated and its operating procedure is outlined, with discussions of period, energy, and spectrometry techniques. The probe window enlargement effect, autoabsorption of β rays, and sensitivity of the method are discussed as they are appropriate to quantitative analysis. The limit of detection of As should be about 1.5×10^{-8}g; for a calculation with a precision of 20% for hair containing 1 mg/kg, the sample (4 mm long) should weigh at least 15 mg. Similarly, 10^{-7}g Na can be determined with a precision of 20%. Using the Saclay E1 3 pile (2×10^{13} neutrons/sec/cm^2) would permit increasing the sensitivity by a factor of 100. Joliot has suggested that metabolic disturbances caused by poisoning may result in greater fixation of Na in the hair; the same fixation may be perhaps detected in persons who eliminate Na poorly (in cirrhosis of the liver, for example). (BBB)

5779 DETERMINATION OF BARIUM IN URANIUM COMPOUNDS BY CONDUCTOMETRIC TITRATION. B. Tomažič and M. Branica (Institut "Ruder Boskovic," Zagreb). Croat. Chem. Acta, 36: 9-12(1964)

A method for determination of barium by conductometric titration in the precipitates of the system uranyl nitrate–potassium hydroxide–barium nitrate, is proposed. The precipitates were dissolved in concentrated nitric acid and uranium separated by means of continuous extraction using tetrahydropyrane. Barium could be determined from 0.6 to 7 mg with a standard error of about 0.12 mg Ba. The lowest gramatomic ratio Ba/U was 1.8×10^{-4}. (auth)

5780 THE DETERMINATION OF FLUORINE AND CHLORINE IN POLYMERS BY A GAMMA ACTIVATED METHOD. L. V. Chepel and F. V. Shemarov. Dokl. Akad. Nauk SSSR, 158: 682-4(Sept. 21, 1964). (In Russian)

The proposed method of determining fluorine and chlorine is based on the following reactions: $^{19}F(\gamma,n)^{18}F$ and $^{35}Cl(\gamma,n)^{34}Cl$. The ^{18}F and ^{34}Cl activities are positron emitters with half lives of 112 and 33 minutes, respectively. Bremsstrahlung radiation from a betatron, which could be controlled at an energy of 4 to 25 Mev, was used to irradiate 100 mg of polymer. LiF and NaCl were used as standards. The threshold for the photonuclear reactions on fluorine and chlorine was ~10 Mev, and the threshold for the reaction on carbon was 18.6 Mev. Hence, the irradiation was carried out with 18 Mev bremsstrahlung radiation in order to avoid the reaction with carbon. The amount of induced activity was determined by scintillation counting of the annihilation gamma (0.511 Mev) at a fixed geometry. The error in determining chlorine was 1.5 to 2.0%, and the error in determining fluorine was 0.5 to 1.0%. Equations are given for the simultaneous determination of F and Cl in a single sample. An analogous method can also be used for the simultaneous determination of C and F, or of C and Cl in a sample. (TTT)

5781 A MASS-SPECTROSCOPIC METHOD OF ANALYZING OXYGEN IN TITANIUM. M. S. Chupakhin, G. G. Glavin, Yu. A. Karlov, and D. V. Kormilitsyn (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 158: 689-91 (Sept. 21, 1964). (In Russian)

The lines of the oxygen-containing compounds TiO, TiO_2, Ti_2O, Ti_2O_2, and Ti_3O in a mass-spectrogram can be used for a quantitative determination of oxygen. The TiO line with a molecular weight of 64 is the most intense. The yield of TiO as a function of the oxygen content was determined on a series of standard samples containing from 0.02 to 1.0 wt. % oxygen (0.06 to 3.0 at. % oxygen). It was found that the concentration of TiO in the sample corresponds to the oxygen concentration in the sample, and is lower by a factor of about 100. The relationship becomes non-linear at an O_2 content >1%. The theoretical sensitivity of the method is about 3×10^{-6} wt. % (1×10^{-5} at. %). Special precautions must be taken to avoid oxygen contamination such as sparking the sample for 30 minutes in the ion source at a vacuum of 10^{-9} torr. A similar method can also be used to determine oxygen in Ni, W, Zr, Ta, Re, Mo, and other metals, if the instrument is first calibrated with standard samples. (TTT)

5782 DETERMINING THE CONTENT OF FREE ALKALINE-EARTH METAL IN OXIDE CATHODES BY MEANS OF RADIOACTIVE IODINE. V. P. Pomazkov and V. P. Vasil'ev. Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1354-9(Aug. 1964). (In Russian)

The method of determining free barium metal was based on the ability of iodine to form a stable compound with free barium and not react with the other components of an oxide layer. With the use of radioactive ^{131}I, it was possible to measure less than 10^{-12} grams of free barium metal at a residual pressure of less than 1×10^{-8} mm Hg std. BaI_2 was formed as a result of the reaction, and the amount of BaI_2 formed could be determined by measuring the amount of activity that reacts with the barium metal. It was found that the concentration of free Ba metal varied from 0.003 wt. % at an oxygen pressure of 5×10^{-4} mm Hg std to 0.06 wt. % at an oxygen pressure of 2×10^{-7} mm Hg std. The Ba metal was distributed homogeneously throughout the volume of the oxide layer. A cathode poisoned by oxygen could be activated by reheating. The data indicated that the electron work function of the oxide layer is smaller with an increasing amount of excess barium metal in the layer. (TTT)

5783 CHRONOPOTENTIOMETRY OF PLUTONIUM IN MINERAL ACID MEDIA. Dennis G. Peters (Indiana Univ., Bloomington) and W. D. Shults. J. Electroanal. Chem., 8: 200-29(Sept. 1964).

The chronopotentiometric behavior of plutonium(III), plutonium(IV), and plutonium(VI) at a platinum electrode in various mineral acid media was studied in order to determine the diffusion coefficients of the different plutonium species, the effects of surface oxidation of the platinum electrode, and the possible analytical usefulness of chronopotentiometry for the determination of plutonium. The reduction of plutonium(IV) to plutonium(III) at a platinum wire cathode in perchloric, sulfuric, nitric, and hydrochloric acid solutions was investigated. The relatively small diffusion coefficient of plutonium(IV) in each of these media plus the spontaneous chemical oxidation of the platinum electrode by plutonium(IV) result in a significant positive error in chronopotentiometry with concentrations of plutonium(IV) below 0.01 M. Chronopotentiograms for the oxidation of plutonium(III) to plutonium(IV) in sulfuric acid show one wave due to oxidation of plutonium(III) followed by a second wave attributable to the formation of a platinum oxide film. Plutonium(III) in sulfuric acid medium chemically reduces the oxide film. The electro-oxidation of plutonium(III) in perchloric acid medium gives a well-defined chronopotentiogram at either pre-reduced or pre-oxidized electrodes. The chronopotentiometric reduction of plutonium(VI) in a 1 F perchloric acid solution proceeds in a step-wise fashion first to plutonium(V) and then to plutonium(III). For the experimental conditions employed, there was no evidence to show that plutonium(V) undergoes significant disproportionation in the perchloric acid medium. (auth)

5784 DETERMINATION OF PROTEIN-BOUND IODINE (PBI) IN HUMAN PLASMA BY THERMAL NEUTRON ACTIVATION ANALYSIS. Edward M. Smith, James M. Mozley, and Henry N. Wagner, Jr. (Johns Hopkins Univ., Baltimore). J. Nucl. Med., 5: 828-39 (Nov. 1964).

Neutron activation analysis was found to be a precise method for measuring PBI in plasma. Passage of human plasma through ion exchange resins in the ammonium acetate form prior to neutron activation removed greater than 99.9% of the inorganic iodide as well as most other inorganic ions. Neutron bombardment of the treated plasma in a nuclear reactor with a flux density of approximately 10^{11} thermal neutrons/cm^2 sec activated ^{127}I to the radioactive isotope ^{128}I. After irradiation, major radiochemical impurities were eliminated by simple radiochemical techniques (stable isotope dilution and differential precipitation). The induced ^{128}I radioactivity was measured and compared to activated iodide standards by gamma spectrometry using spectrum stripping to eliminate interference from remaining radioactive contaminants. The activation analysis technique yielded results that were systematically 1.8 μg/100 ml higher than the Barker chemical method although thyroxine recovery studies run on both procedures were identical. The systematic difference could not be attributed to any systematic error in the activation analysis procedure indicating this technique may be measuring an additional iodine component of plasma such as iodotyrosines. Advantages over chemical methods of measuring PBI are elimination of the protein digesting step, elimination of the reagent blank, and a reduction in the problem of iodine contamination. (auth)

5785 HAFNIUM AND ZIRCONIUM ANALYSIS BY X-RAY FLUORESCENCE METHOD. E. Ramous (Universita, Padua). Met. Ital., 56: 473-6(Oct. 1964). (In Italian)

A method for hafnium determination by x-ray fluorescence when zirconium is present was studied. This method is based on the different excitation of hafnium with respect to zirconium; for its determination the HfLα line was used. Measurement reliability for hafnium contents ranging from 100 to 200 ppm was ± 45 ppm while with hafnium contents of about 2% an accuracy of ±1.5% was achieved. A good accuracy (±1%) was also possible for zirconium determination in hafnium. (auth)

5786 DETERMINATION OF ^{140}Ba IN URANIUM FISSION PRODUCT MIXTURES. H. Sorantin and H. Bildstein (Osterreichische Studiengesellschaft fur Atomenergie, Vienna). Monatsh. Chem., 95: 785-94(1964). (In German)

A rapid method for the determination of ^{140}Ba in mixtures of U fission products was developed after examination of the separation methods for ^{140}Ba in the literature. The method consists of ether–HCl precipitation of $BaCl_2 \cdot 2H_2O$ after a combined $Al(OH)_3$–$La(OH)_3$ precipitation. Recipes for artificial fission product mixture solutions are given, and stock solutions and apparatus for the procedure are outlined. Checks on the efficacy of individual steps of the procedure are outlined, and several representative gamma spectra are reproduced. Among these are spectra of the original solution, the $La(OH)_3$–$Al(OH)_3$ precipitate, $BaCl_2 \cdot 2H_2O$ precipitate, Ba-containing solution after the precipitation, and the final $BaSO_4$ precipitate. After the first ether-HCl precipitation, recrystallization of the $BaCl_2 \cdot 2H_2O$ changes the spectrum slightly; a slight decontamination of ^{95}Zr was noted by this method. The method suggested for rapid analysis incorporates a double $BaCl_2 \cdot 2H_2O$ precipitation and a $Zr_3(PO_4)_4$ precipitation as a scavenger step and to remove ^{95}Zr traces. The yield of the reaction sequence is 70%,

measurements may be carried out to ±2%, and double determinations require 45 min until final precipitation plus 90 for drying and mounting the precipitate. A decontamination factor for ^{90}Sr of 10^3 was measured. (BBB)

5787 RAPID DETERMINATION OF YTTRIUM BY NEUTRON ACTIVATION AND γ-RAY SPECTROMETRY. Minoru Okada (Government Chemical Industrial Research Inst., Tokyo) and Yuichiro Kamemoto. Nippon Kagaku Zasshi, 85: 641-2(Oct. 1964). (In Japenese)

An attempt was made to determine yttrium by neutron activation analysis. The method investigated consists of irradiation of sample in a pile-neutron flux of 3×10^{11} n/cm²/sec for 14 sec using a cadmium container to reduce interference by ^{165m}Dy and observation of γ spectra of the produced ^{89m}Y. Yttrium contents of gadolinite and samarskite were determined by this method. Possible interferences due to ^{89m}Y produced from ^{90}Zr, ^{91}Zr, and ^{93}Nb and due to ^{20}O were examined and found to be small. (auth)

5788 DETERMINATION OF GOLD IN SEA WATER BY NEUTRON ACTIVATION ANALYSIS. Yoshinago Oka (Tohoku Univ., Sendai), Toyoaki Kato, and Michio Sasaki. Nippon Kagaku Zasshi, 85: 643-7(Oct. 1964). (In Japanese)

Determination of gold in sea water by radioactivation analysis was carried on surface and sub-surface samples collected at various distances offshore from the Pacific coast of the Tohoku district. The samples were irradiated with thermal neutrons in the JRR-2 reactor at a flux of 2×10^{13} n/cm²/sec for 72 hr and the radioactivity from the ^{198}Au produced was compared with that from a standard gold solution. Results of analysis of 14 surface and 7 sub-surface samples collected in the region of 37 to 41°N, 141 to 147°E showed concentrations of 6 to 430 μg Au/m³. The gold content varied in different localities and was relatively high in the region on the borders of the Kurile and the Black streams of sea water. Amounts of gold found in deep-sea water were somewhat smaller than those found in surface water. (auth)

5789 SPECTROPHOTOMETRIC DETERMINATION OF BERYLLIUM IN HIGH MANGANESE–ZINC ALLOY. Kazuo Ota. Nippon Kinzoku Gakkaishi, 28: 330-4 (1964). (In Japenese)

Acetylacetone-chloroform extraction involving the use of ethylenediamine-tetraacetate as a masking agent for foreign metals was applied to the determination of beryllium in a manganese–zinc alloy. The rapid spectrophotometric method was established with good accuracy and reproducibility in the range from 0.002 to 1.0% beryllium. Some factors affecting the absorbance were investigated. Suitable pH for extraction was 7.2 to 9.4, and its adjustment was simplified by using phenol red indicator. The stabilized period of absorbance of the extracted acetylacetonate phase varied with the coexisting time of aqueous and organic phases after extraction. Maximum stability was obtained at the coexistence time of 5 to 10 minutes, but the absorbance measured in 5 minutes gave a correct result even without the coexisting time. As the salting-out agent any of NaCl, Na_2SO_4 or $NaNO_3$ was successfully used. (auth)

5790 NEW METHOD OF RADON ACTIVITY MEASUREMENT WITH LIQUID SCINTILLATOR. Masayasu Noguchi (Japan Atomic Energy Research Inst., Tokyo). Radioisotopes (Tokyo), 13: 362-7(Sept. 1964). (In Japanese)

A simple method was developed for Rn measurement using a liquid scintillator that depends upon the fact that Rn has a large solubility in toluene, which is used as the scintillation solvent. The method is convenient for the measurement of Rn gas concentration, especially in water. (P.C.H.)

5791 STUDIES ON MEASUREMENT OF MOISTURE CONTENT BY NEUTRON SCATTERING. Saburo Sakamoto (Hokkaido Univ., Japan), Taikichi Hattori, and Sadao Sawada. Radioisotopes (Tokyo), 13: 368-75(Sept. 1964). (In Japanese)

A method for the measurement of moisture content in thin slabs of organic and inorganic substances with high precision using a Ra + Be neutron source, a BF_3 counter, and a block of paraffin is described. The paraffin block is kept as close as possible to the detector and the test sample. Asbestos slabs and plywoods ranging from 0.15 cm to 0.65 cm in thickness were used as test samples, and experiments indicated that the counting rate curves plotted against moisture content are almost linear with respect to the test samples. If the asbestos and plywood are of the same thickness, the efficiency of moisture detection in the asbestos slab is superior to that in the plywood. The efficiency of moisture detection increases as the paraffin increases in quantity and the same case occurs on the thickness of the test sample as it increases. The detectable minimum moisture content in the asbestos slab of 0.65 cm in thickness is 2.7% (0.019 g/cm³). (P.C.H.)

5792 DETERMINATION METHOD OF ^{137}Cs IN LARGE QUANTITIES OF TOTAL DIET BY USING PHOSPHO-AMMONIUM MOLYBDATE. Mariko Kashiwagi and Jun Akaishi (Japan Atomic Energy Research Inst., Tokyo). Radioisotopes (Tokyo), 13: 382-8(Sept. 1964). (In Japanese)

A simple procedure is described for the determination of ^{137}Cs in a total diet (5-days sample). Cesium carrier was added to the ashed sample. The sample was treated with hydrochloric acid. Calcium contained in the sample was separated as a carbonate precipitate. The filtrate was acidified with nitric acid. By adding phosphoric acid and ammonium molybdate to the solution, ^{137}Cs was co-precipitated with phospho-ammonium molybdate. The amount of ^{137}Cs in the precipitate was measured by γ spectrometry. In the co-precipitation step, effects of factors such as temperature, amount of phosphoric acid and ammonium molybdate added, acidity of the solution, etc. were observed. Interference of potassium and ammonium was also measured. It was found that potassium, ammonium, and phosphate contained in the diet do not interfere with the co-precipitation of ^{137}Cs; contamination of the phospho-ammonium molybdate by co-existing ^{95}Zr–^{95}Nb and ^{106}Ru–^{106}Rh is small; and recovery of ^{137}Cs by this procedure is nearly 100%. (auth)

5793 RADIOMETRICAL METHODS OF ORE ANALYSIS. Part I. Bohdan Dziunikowski. Rudy Metale Niezelazne, 9: 550-3(1964). (In Czech.)

The necessity of developing rapid methods for determination of metal contents in ores is discussed. The physical basis of the radiometric absorption method is presented. The difficulties of its application in analysis of multicomponent systems are discussed. A description is given of the principles of an original nomographic method enabling the determination of lead in polymetallic ore samples. Experimental results obtained with the method are presented. (auth)

5794 X-RAY-SPECTRAL ANALYSIS OF LANTHANIDES ACCORDING TO K SPECTRUM. G. V. Bondarenko and M. A. Blokhin (Inst. of Physics, Academy of Sciences, Siberian, USSR and Rostov State Univ., USSR). Zavodsk. Lab., 30: 1337-8(1964). (In Russian)

A method is given for x-ray-spectral analysis of lanthanides (La, Ce, Pr, Nd, and Sm) according to K spectra. The sensitivity of the method is identical to that employing L spectra. (tr-auth)

5795 CHEMICO-SPECTROGRAPHIC DETERMINATION OF RARE-EARTH IMPURITIES IN RARE EARTH BASE. Sh. G. Melamed, A. S. Kostygov, and T. V. Lishchenko. Zavodsk. Lab., 30: 1339-43(1964). (In Russian)

A method is given for the chemico-spectrographic determination of rare-earth impurities in high-purity Y, Nd, Pr, and La oxides. The method is based on ion-exchange chromotography of the impurities followed by spectrographic analysis of enriched products. (tr-auth)

5796 A COMPARATIVE STUDY OF CERTAIN REAGENTS FOR SCANDIUM. D. I. Ryabchikov, S. B. Savvin, and Yu. M. Dedkov (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Analit. Khim., 19: 1210-18(1964). (In Russian)

A comparative study was made of color reactions of scandium with 18 organic reagents. It was shown that by their sensitivity, selectivity, and maximum admissible acidity the most suitable for the photometric determination are arsenazo III, 2,4-sulfochlorophenol S, and 2,4-sulfochlorophenol R, and, for the complexonometric determination, xhylenol orange, arsenazo III, and 2,4-sulfochlorophenol S. An extraction-photometric method was suggested for increasing the selectivity of scandium determination in the presence of rare earths and a number of other elements. The method includes extraction of the diphenylguanidinium salts of the scandium complexes with 2,4-sulfochlorophenol S or 2,4-sulfochlorophenol R using butyl alcohol followed by measuring the optical density of the extract. The method permits determination of 0.01% of Sc in rare earth compounds. (auth)

5797 ANALYSIS OF ESSENTIAL NUCLEAR REACTOR MATERIALS. Clement J. Rodden, ed. (New Brunswick Lab., AEC, N. J.). 1964. 1291p. $4.25(GPO).

This book presents published and previously unpublished information on the analysis of essential materials used in reactors. The 16 chapters cover the various materials and methods; separate abstracts were prepared for all of the chapters. (D.L.C.)

For abstracts of individual chapters see: 5798, 5799, 5800, 5801, 5802, 5803, 5804, 5805, 5806, 5807, 5808, 5809, 5810, 5811, 5812, and 5813.

5798 URANIUM. C. J. Rodden (New Brunswick Lab., AEC, N. J.). p.1-157 of "Analysis of Essential Nuclear Reactor Materials." GPO.

A review is presented of the analytical chemistry of uranium. The chemistry of uranium and its compounds are considered briefly. Methods of separation and determination of uranium are discussed in detail. (D.L.C.)

5799 PLUTONIUM. Charles F. Metz and Glenn R. Waterbury (Los Alamos Scientific Lab., N. Mex.). p.159-292 of "Analysis of Essential Nuclear Reactor Materials." GPO.

The background and chemistry of plutonium are discussed. Methods for the analysis of plutonium-containing materials are reviewed in detail. (D.L.C.)

5800 THORIUM. Robert Z. Bachman and Charles V. Banks (Ames Lab., Ames, Iowa). p.293-348 of "Analysis of Essential Nuclear Reactor Materials." GPO.

The background of thorium and its compounds is surveyed briefly. The dissolution of thorium and its compounds and the qualitative detection of thorium are considered. Methods of separation and determination of thorium are reviewed in detail. (D.L.C.)

5801 BERYLLIUM. C. J. Rodden (New Brunswick Lab., AEC, N. J.). p.349-405 of "Analysis of Essential Nuclear Reactor Materials." GPO.

A review is presented of the analytical chemistry of beryllium. Dissolution and separation methods are discussed. Methods for determination of beryllium in metal and oxide and for analysis of beryllium for impurities are described. (D.L.C.)

5802 ALLOYS AND CERAMICS. R. W. Bane (Argonne National Lab., Ill.). p.407-90 of "Analysis of Essential Nuclear Reactor Materials." GPO.

A review is presented of the analytical chemistry of alloys and ceramics used as reactor fuels. The alloys covered include Al, Zr, stainless-steel, Mo, Bi, and fissium alloys. Pu alloys and dissolution of ceramics are considered in detail. (D.L.C.)

5803 EXPENDED REACTOR FUELS. G. L. Booman and J. E. Rein (Phillips Petroleum Co., Idaho Falls, Idaho). p.491-540 of "Analysis of Essential Nuclear Reactor Materials." GPO.

A review is presented of methods which are used in analytical programs carried out on irradiated fuels for process control and fuels evaluation. Facilities and apparatus are described briefly. Separation processes for U and Pu are considered. These processes include HNO_3 recovery process for Al-U fuel, HF process for U-Zr fuel, H_2SO_4 process for stainless steel-U fuel, fluoride-volatility process, pyrometallurgical process, HNO_3 process for irradiated Th, and process for homogeneous-reactor fuel. (D.L.C.)

5804 GRAPHITE. F. E. Clark (Union Carbide Corp., Carbon Products Div., Lawrenceburg, Tenn.). p.541-76 of "Analysis of Essential Nuclear Reactor Materials." GPO.

The history and production problems of nuclear-grade graphite are described. Sampling of graphite for analysis is discussed. Chemical and physical methods for determination of impurities and C in graphite are reviewed in detail. (D.L.C.)

5805 BORON. M. W. Lerner (New Brunswick Lab., AEC, N. J.) and J. Rynasiewicz. p.577-628 of "Analysis of Essential Nuclear Reactor Materials." GPO.

A review is presented of the analytical chemistry of boron. Boron standards are discussed briefly. Methods for the separation of boron from materials are described, and possible losses and contamination are considered. Methods for determination of boron in various concentration ranges and of impurities in boron are reviewed. (D.L.C.)

5806 HEAVY WATER. C. E. Anderson and D. G. Ebenhack (Savannah River Plant, Aiken, S. C.). p.629-57 of "Analysis of Essential Nuclear Reactor Materials." GPO.

A review is presented of analytical methods that are used in the routine control of heavy-water moderator. These methods cover the determination of deuterium oxide and impurities and include measurement of physical properties as well as isotopic and chemical methods. (D.L.C.)

5807 REACTOR COOLANTS. W. C. Judd (Nuclear Materials and Equipment Corp., Apollo, Penna.), D. Dutina, and C. J. Rodden. p.659-718 of "Analysis of Essential Nuclear Reactor Materials." GPO.

A review is presented of methods used in the analytical control of reactor coolants. The coolant types that are covered include water, gas, liquid-metal (Na and K-Na), and polyphenyl. (D.L.C.)

5808 TRACE ELEMENTS. M. W. Lerner (New Brunswick Lab., AEC, N. J.). p.719-900 of "Analysis of Essential Nuclear Reactor Materials." GPO.

A table is presented of thermal-neutron cross sections and danger coefficients for impurity elements. Analytical methods are reviewed in detail for the determination of O, H, N, C, and other trace impurities in reactor materials. (D.L.C.)

5809 SPECTROCHEMICAL METHODS. Harold R. Mullin and Clara Gale Goldbeck (New Brunswick Lab., AEC, N. J.). p.901-86 of "Analysis of Essential Nuclear Reactor Materials." GPO.

A detailed review is presented of spectrochemical methods for the determination of reactor materials and trace impurities therein. Isotopic determinations and chemical separations are also considered. (D.L.C.)

5810 MASS SPECTROMETRY. A. E. Cameron (Oak Ridge National Lab., Tenn.) and C. M. Stevens. p.987-1109 of "Analysis of Essential Nuclear Reactor Materials." GPO.

Mass spectrometry is used for the isotopic analysis of U, Pu, H, Li, and B because the isotopic compositions of these reactor materials are important in reactor operation. A review is presented of methods for the mass spectrometry of UF_6, B, and Li. Isotopic analysis of solid samples by surface ionization is also discussed in detail. (D.L.C.)

5811 RADIOCHEMICAL AND NUCLEAR METHODS. S. A. Reynolds (Oak Ridge National Lab., Tenn.). p.1111-28 of "Analysis of Essential Nuclear Reactor Materials." GPO.

Techniques and apparatus for radiochemical analysis are described. Activation analysis and neutron absorptiometry are discussed. Assay by radioactivity measurements is described for U, Th, Ra, and Pa, and the isotopic analysis of U, Th, and Li is considered. (D.L.C.)

5812 ELECTROMETRIC METHODS. W. N. Carson, Jr. (General Electric Co., Schenectady, N. Y.). p.1129-1218 of "Analysis of Essential Nuclear Reactor Materials." GPO.

A review is presented of the electrometric techniques used in the analysis of atomic energy materials. The techniques covered are those in which an electrochemical phenomenon is involved; they include potentiometry, coulometry, voltammetry, conductometry, dielectric-constant measurement, and indirect (reagent and indicator) methods. The principles of the apparatus used in the techniques are also discussed. (D.L.C.)

5813 X-RAY SPECTROSCOPY. C. G. Goldbeck (New Brunswick Lab., AEC, N. J.). p.1219-51 of "Analysis of Essential Nuclear Reactor Materials." GPO.

A review is presented of the analysis of nuclear materials by x-ray absorption and emission. (D.L.C.)

5814 RADIOISOTOPE DILUTION AND ITS APPLICATION TO THE RADIOASSAY OF Ce^{144}. L. A. Currie, G. M. France, III, and H. L. Steinberg (National Bureau of Standards, [Washington, D. C.]). 23p. (CONF-179-13).

From American Chemical Society Radionuclidic Exchange on Soils, Minerals, and Resins, Philadelphia, Apr. 1964.

General equations are presented relating the final result and its precision to the extent of mutual interference and to the isotope ratio employed in the analysis of ^{144}Ce by isotope dilution. A graphical representation allows the precision with which the isotope ratio may be determined and the range of ratios which may be utilized to be estimated. The method was applied to the analysis of ^{144}Ce, using ^{139}Ce as the diluting radioisotope. The effects of chemical yield (varying by a factor of 5) and isotope ratio (varying by a factor of 500) were experimentally evaluated. Consistent results were obtained in the analysis of a vegetable sample distributed for international comparison by the International Atomic Energy Agency, using gamma spectroscopy (on the entire sample) and by radioisotope dilution. (P.C.H.)

5815 RADIOMETRIC END-POINT DETECTION IN REDOX AND COMPLEXOMETRIC TITRATIONS. T. Braun and E. Koroes (Lorand Eötvös Univ., Budapest). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/17, 21p. (CONF-641001-4)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

Using solvent extraction, two cases are discussed: titration using radioactive standard solution and titration of labeled components using inactive standard solution. Indication by radioactive amalgams was used in Redox titrations. Liquid amalgam with labeled ^{65}Zn or ^{115}Cd serves as indicator. After the total amount of the reducing agent is oxidized, the oxidizing agent reacts with the amalgam and an equivalent amount of ^{65}Zn or $^{115}Cd^{2+}$ ions appears in the solution. The appearance of the radioactivity in the solution causes a break in the titration curve. One new technique which has been applied is the use of radioactive precipitate membranes for continuous radiometric titration. Further, a circulating system titration apparatus using precipitate membranes as indicators is described. An apparatus was also designed for continuous solvent extraction and for continuous measurement of the radioactivity which rendered both the circulation of the aqueous phase and the organic phase. (P.C.H.)

5816 THE USE OF ACTIVATION ANALYSIS FOR DETERMINING SPECIFIC ACTIVITIES DURING QUANTITATIVE ANALYSIS BY ISOTOPIC DILUTION. J. Pauly, E. Sabbioni, and F. Girardi (EURATOM, Ispra, Italy). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/11, 16p. (CONF-641001-30). (In French)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

Neutron activation analysis was used for measuring certain elements (La, Ce, Ru, Mo, etc.) in a uranium alloy. Activation analysis cannot be used directly in solving this analytical problem since the radioisotopes obtained by the (n, γ) reaction are also produced by uranium fission. The isotopic dilution method, on the other hand, appears to be suitable since it is difficult to separate quantitatively the elements being determined, particularly if, in order to avoid contamination, only small quantities of specially selected reagents may be used. Trace determinations were carried out by attacking the alloy and adding to the solution a radioactive tracer of the element to be measured. This was separated, care being taken to eliminate the uranium completely. The residual activity was measured and the weight needed for calculating the specific activity determined by neutron activation. Precautions were taken to distinguish between the activity added as a tracer and the activity produced by activation. Tests were conducted with mixtures of known composition in order to check the reproducibility and accuracy of this method. Its sensitivity was also assessed and found normally to be a little less than, but under favorable conditions of the same order as, that which would have been obtained if it had been possible to apply activation analysis to the samples directly. (P.C.H.)

5817 ACTIVATION ANALYSIS OF SOME LIGHT ELEMENTS IN VARIOUS MATERIALS USING CHARGED PARTICLES (α AND p). Ch. Engelmann (Centre d'Etudes Nucleaires, Saclay, France). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/67, 19p. (CONF-641001-28). (In French)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

A method of interpretation using the concept of equivalent thickness and reducing the calculations of content to operations which are as simple as those employed with neutrons or gamma rays was developed. The method is applied mainly in measuring traces of oxygen, carbon, and fluorine. The sensitivity of the method in practice and the interferences created were examined. (P.C.H.)

5818 THE USE OF ION EXCHANGE RESINS FOR RAPID CHEMICAL SEPARATION IN ACTIVATION ANALYSIS: DETERMINATION OF IODINE IN BIOLOGICAL FLUIDS. D. Comar and C. le Poec (Service Hospitalier Frédéric Joliot, Orsay, France). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/79, 12p. (CONF-641001-50). (In French)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

When irradiating biological samples with thermal neutrons, it was noted that in most cases the bonds between the proteins and the trace elements were broken, so that they could be isolated with a high degree of radiochemical purity by means of a simple chemical treatment. It was therefore possible to develop a method for the semi-automatic determination of iodine in biological fluids. Radiochemical purification was carried out using ion exchange resins, and 10 samples were treated simultaneously over a period of less than 30 minutes. After passage of the biological fluid through a small Dowex 2 × 8 column the chlorine and bromine are eluted by a sodium nitrate solution, while the iodine remains trapped on the resin. The iodine is then eluted by a more concentrated sodium nitrate solution and precipitated as silver nitrate. All these operations are carried out automatically. The results obtained for the determination of total plasma iodine, protein-bound iodine, and urinary iodine are presented in such a way as to be comparable with other activation methods for determining iodine. The possibility of extending this method to the separation of other trace elements in biological media is discussed. (auth)

5819 ANALYSIS OF THE IRON, ZINC AND COPPER ORES IN THE FIELD AND LABORATORY USING THE X-RAY FLUORESCENCE EXCITED BY THE H^3/Zr BREMSSTRAHLUNG SOURCE. T. Florkowski, B. Dziunikowski, A. Kosiara, and M. Wasilewska (Inst. of Radioisotope Techniques, Academy of Mining and Metallurgy, Krakow). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/95, 14p. (CONF-641001-39)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

A fluorescent analysis method using a ^{3}H/Zr bremsstrahlung source in the application to the iron, zinc, and copper ores is described. Two versions of the method (a laboratory and a field one) were investigated. In the first version a proportional counter with Be window together with a single- or double-channel pulse-height analyzer was used for the detection of the characteristic x rays excited in the sample. In the field method the GM counter with a mica end window of 36 mm diameter and 2 mg/cm^2 thickness was combined with the transistorized scaler or rate meter. For the separation of the interesting x-ray line the balanced-edge filter method was applied. The factors disturbing the analysis were the matrix and enhancement effects connected with various ore lithological structures and varying concentration of the adjacent elements. In the case of zinc and copper ores, iron is an element like this and must be additionally determined. In the laboratory method the two-channel counting was used for measuring the intensity of Zn and Fe or Cu and Fe K x rays. A nomographic method was developed for the rapid determination of the concentrations of both elements depending on the relative count rates in both channels. In the field instrument the edge filter technique was used instead of the analyzer. Other factors influencing the result of the analysis, such as the humidity of the ore, the pulverizing grade, or the smoothness of the solid ore piece used as a sample, were also investigated. An easy way for estimating the sensitivity of the method from the calibration curve is given, and was used for defining the accuracy of the analysis in the various ranges of concentrations. The time necessary for the analysis is 1 to 5 minutes. The methods developed seem to be convenient for application in the ore mining industry both directly in the mine and in the industrial laboratory. The main advantages are the simplicity, low costs, and short time needed for the analysis. Since the analysis is a non-destructive one, it can be readily repeated and checked by classical methods. (P.C.H.)

5820 NEUTRON ACTIVATION ANALYSIS OF TRACE ELEMENTS IN WHITE LEAD AND THE POSSIBLE APPLICATION FOR AGE DETERMINATION OF PAINTINGS. J. P. W. Houtman and J. Turkstra (Reactor Instituut, Delft, Netherlands). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/91, 24p. (CONF-641001-41)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

The determination of traces of silver, mercury, zinc, and copper in white lead samples can give a decisive answer as to whether a painting was made before or after approximately 1850. Traces of cobalt, chromium, barium, and antimony are also to a more or less extent present in white lead. Analyses were carried out with a number of very small white lead samples taken from different original paintings made in the period between 1500 and 1960 using neutron activation analysis. After irradiation the different elements were separated by precipitation and extraction techniques. (P.C.H.)

5821 AUTOMATIC ANALYTICAL CONTROL OF SOME COMPONENTS OF COMMERCIAL PHARMACEUTICALS ON THE PRINCIPLE OF BACKSCATTERED BETA RADIATION. P. Schiller (Comenius Univ., Bratislava). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/88, 10p. (CONF-641001-24)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

A routine radiometric method based on measuring intensity of backscattered beta radiation was developed for determining some ingredients of pharmaceutical preparations manufactured on a large scale. The common knowledge that the backscattered beta radiation intensity increases, under certain conditions, with atomic number of the backscattering substance was applied. The proper process control method was developed in accordance with the requirement of processing practice. Technical specifications prescribe a definite minimum and maximum limit of checked ingredient concentration in substance. The radiometric control method consisted of preparing standards with both minimum and maximum concentration, measuring the respective intensity of backscattered beta radiation, and at manufactured preparations an estimation was sufficient as to whether the measured intensity value remains within the prescribed concentration limits of checked element. The radiometric process control method proved successful in industry. The equipment used is described. (P.C.H.)

5822 He^3 ACTIVATION ANALYSIS FOR CARBON. S. S. Markowitz and J. D. Mahony (Univ. of California, Berkeley). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/46, 16p. (CONF-641001-19)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

A simple and rapid activation analysis for carbon was developed that utilizes the reaction $^{12}C(^3He,\alpha)^{11}C$ induced by relatively low-energy ^{3}He ions. The method is nondestructive requiring only milligram amounts of sample; the ultimate sensitivity is fractions of a part per billion. The excitation function for the reaction was determined by irradiation of stacked foils of polystyrene with 0 to 31-Mev ^{3}He ions. Irradiations were about 10 to 20 minutes and the beam currents were only about 10 mμA. The radioactivity of the product ^{11}C, a 20.4-min positron emitter, was determined with proportional counters. The cross section rises from a threshold at about 3.5 Mev to a maximum of 320 mb at 10 Mev and then decreases exponentially to 55 mb at 31 Mev. The Q-value for the reaction is +1.9 Mev and the Coulomb barrier is 3 Mev. The excitation function for the production of 10.0-min ^{13}N from $^{12}C(^3He,np)$ was also determined; it peaks at 15 Mev and does not interfere with the carbon determination because of the energy dependence and the half life difference. The presence of beryllium in comparable amounts to that of the carbon would be an interference; this, however, would be eliminated by the use of the $^{12}C(^3He,n)^{14}O$ reaction to determine the carbon. The nuclide, ^{10}B, would also constitute an interference that can be eliminated by a change of the detecting reaction. Substances of atomic number greater than 6 will not produce ^{11}C at low ^{3}He energy. The production of other radioactivities from $Z > 6$ constituents in the target or from the target matrix itself can be easily prevented by bombarding at a ^{3}He energy lower than the Coulomb barrier. Spectra obtained from the interaction of gamma rays with lithium-drifted germanium crystals at 77°K are presented and application of this new detector to activation analyses when low sensitivity is not a requirement is suggested. Several gold foils were analyzed for carbon and oxygen (by $^{16}O(^3He,p)^{18}F$ reaction) simultaneously and found to contain 0.01% ^{12}C and 0.006% ^{16}O. (P.C.H.)

5823 TWO FORTRAN-PROGRAMS FOR COMPUTING ACTIVITIES BY ACTIVATION ANALYSIS. H. Muenzel (Kernforschungszentrum, Karlsruhe, Ger.). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/32, 8p. (CONF-641001-6)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

Two programs for computing the activity of the components in a mixture of radionuclides were developed for an IBM-7070 computer. The program RADAR is for analyzing decay curves for the Activity A_0 of a maximum of five components at the time T_0. The half lives T of the components may be fed in as being exactly known, known better than to a factor 2, or unknown. The measured results are corrected for background, deadtime of the measuring equipment as well as for the standardization resulting from standard measurements. The program BRITTA

is for computing the activity percentages of a maximum of five components in a gamma spectrum by means of the least squares method. In doing so it is assumed that the gamma spectra of the individual components (reference spectra) are known for the measuring arrangement used. The result of the analysis supplied by BRITTA yields the activity percentages of the components contributing to the total spectrum. Moreover, FQ, X^2, and D are computed. Elaboration and application of the programs as well as the counting device used for simplifying mechanical evaluation of the measured results are described. (P.C.H.)

5824 NEW EXPERIMENTS IN RADIOACTIVATION ANALYSIS WITH GAMMA QUANTA OF 18 TO 27 Mev. E. Schweikert and Ph. Albert (Centre National de la Recherche Scientifique, Vitry-sur-Seine, France). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/66, 19p. (CONF-641001-35). (In French)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

Twenty-four elements were irradiated with photon bremsstrahlung from a linear accelerator. Measurement of their specific activities indicated the extent to which activation analysis by photons is possible. The different elements were irradiated at 27 Mev. For titanium, zirconium, niobium, and hafnium curves of activation were plotted against energy varying from 20 to 27 Mev. It was noted that for these elements activity increased with increasing energy, but that the levels of activity were very different for each element. The activities measured for elements irradiated at a fixed energy (27 Mev, 50 μA of mean electron current) enabled the elements to be placed into two categories: elements of low specific activity (0.1 to 25 cpm/μg following irradiation to saturation or for a maximum duration of two hours) or of very short half life, and elements of high specific activity (from 250 to 5000 cpm/μg following irradiation to saturation or for a maximum duration of two hours at 27 Mev, 50 μA of mean electron current). The possibility of determinations in cases where activation by neutrons is difficult or impossible, for such reasons as extremely short half life, competing reactions, or excessively small activation cross sections, was examined. Possible analytical applications were examined: nondestructive determination of zirconium in hafnium using ^{89m}Zr; and determination with chemical separation (determination of titanium in copper and iron using ^{45}Ti and determination of nickel in copper using ^{57}Ni). (auth)

5825 HEAVY ELEMENTS CONTENT MEASUREMENT BY MEANS OF A RADIOACTIVE METHOD OF X-RAY FLUORESCENCE ANALYSIS. P. Martinelli (Centre d'Etudes Nucléaires, Saclay, France) and P. Blanquet. Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/77, 23p. (CONF-641001-32). (In French)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

The possibilities of measuring the high-atomic-number elements of samples by excitation of their characteristic K-x-rays with γ radiations emitted by radioactive sources were studied. The intensity of the radiation scattered by Compton effect was used to correct the x K line intensities. The density effect on the measurement of high atomic number element is therefore highly diminished; it is the same for the grain-size effect and the chemical form effect. This makes possible the measurement on bulk materials and on-stream measurements. Because of the relatively high energy of the K-x-ray lines it is also possible to have thick walls between the samples and the measuring system. This principle was applied to the measurement of lead content in mixtures of $PbS-SiO_2-ZnS-FeS_2$. The source used was ^{192}Ir, the detector a NaI(Tl) crystal and a photomultiplier. The effects of grain size, density, chemical form, incidence and observation angles, crystal thickness, deepness of the layer examined, etc., on the lead K-x-ray intensities are illustrated. Results obtained show that it is possible in practice to have the lead content with an absolute sensitivity of 0.5%. Other experiments showed that it is possible to measure the tungsten content of steels with an absolute sensitivity of 0.5%, using samples of given size. Results obtained in the measurement of heavy metal content in water solutions are also given, mainly for tungsten, mercury, lead, bismuth, and uranium. (P.C.H.)

5826 RADIOACTIVE METHOD OF ANALYSIS BY X-RAY FLUORESCENCE OF LIGHT ELEMENTS. A. Robert and P. Martinelli (Centre d'Etudes Nucléaires, Saclay, France). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/76, 25p. (CONF-641001-7)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

The possibilities offered by radioactive isotopes in the excitation of light elements that are a challenge for x-ray analysis were investigated. The main difficulties encountered in x-ray fluorescence analysis of light elements arise from their low x-ray yields and the very low energies of the emitted photons which are characterized by their very high absorption coefficients. In order to detect these very low energies, a proportional counter was built in such a way that the fluorescence photons can enter the counter without having to go through a window. This way of detection was made possible by the introduction of another electrostatic field that is opposed to the main field. The excitation by the radioisotope is being made in an atmosphere that is common to that of the counter; an optimum pressure is defined for the detection yield in such a manner that this yield remains constant when adjusting the pressure to the energy to be detected. The x-ray spectrum emitted by the sample is obtained by pulse-height discrimination of the electric pulses given by the proportional counter. ^{55}Fe and ^{3}H/Zr were used as x-ray emitters and ^{210}Po as gamma emitter. The x-ray sources are convenient for the excitation of the elements of the third period of the periodic classification. The alpha radiation was proved to be very efficient for the excitation of the first elements of the third period and for the last of the second period. By this process the K α x rays of fluorine, oxygen, and carbon were obtained. The excitation by α particles appears to be promising for the light and very light elements; this simple solution could, under favorable circumstances, be substituted for more complex methods which are used by the conventional techniques. The process is illustrated by the analytical determination of a light element. (P.C.H.)

5827 DETERMINATION OF IMPURITIES IN REACTOR GRADE URANIUM OXIDE. M. Oerdoegh, E. Szabó, and D. Hegedues (Central Research Inst. for Physics, Budapest). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/110, 16p. (CONF-641001-11)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

A new method is presented for the investigation of reactor-grade uranium compounds by neutron activation; in the technique developed the bulk of uranium is removed from the sample by paper chromatography prior to irradiation. Diethyl ether solvent with 5% v/v nitric acid and Schleicher-Schüll 2043a paper are used, applying the descending flow-through technique. The nitric acid-ether mixture removes the uranium (about 100 mg spotted) which leaves the paper while other cations remain at the starting position. Also thorium can be removed by this solvent though not so fast as uranium. Upon its removal by paper chromatography uranium cannot be detected even in the lower part of the paper by potassium ferrocyanide. In-pile irradiation, however, induces considerable neptunium-239 and some fission product activities, therefore chemical treatment is necessary. Chemical separation methods were developed for the identification of the following elements, grouped into three classes with respect to their chemical and nuclear properties, namely, cadmium, copper, molybdenum (rare earths); silver, cadmium, cobalt, nickel, chromium (phosphorus, iron); and nickel, manganese, silicon. The separation technique was chosen to isolate neptunium-239, the fission products, and the elements in question from one another. This was achieved by precipitation, extraction,

and ion exchange and the purity of the separated products was checked by half life, maximum energy, and gamma spectrum measurements. A technique was also developed for the simultaneous determination of 6 elements by gamma spectrometry. Possible interferences of (n,p) and (n,α) reactions for elements of closely spaced atomic weights were evaluated by calculations. (P.C.H.)

5828 A NON-DESTRUCTIVE ACTIVATION ANALYSIS FOR THE DETERMINATION OF Co IN Ni USING A COMPTON COMPENSATED GAMMA SPECTROMETER. D. DeSoete and J. Hoste (Université, Ghent). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/4, 11p. (CONF-641001-18)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

A nondestructive activation analysis is proposed for the determination of Co in Ni by measuring the activity of the 1.17- or the 1.33-Mev gamma ray of ^{60}Co versus the 0.51- or the 0.8-Mev gamma of ^{58}Co. The latter, produced by the ^{58}Ni(n,p)^{58}Co reaction, due to the fast neutron flux, is used as an internal standard. The use of a net photospectrum avoids the correction of the ^{58}Co activity due to the Compton continuum of ^{60}Co. The compensated spectrum is obtained by subtracting the Compton effect of a NaI(Tl) detector by means of an organic plastic scintillator giving rise to Compton effect only. A lead grating positioned between the source and the plastic corrects for the total absorption of gamma rays in the NaI(Tl) detector produced by multiple scattering. A calibration curve was established using an addition method on Co-free Ni powder. By irradiating the samples at different thermal/fast neutron fluxes the determination is feasible in the concentration range of 10^4 down to 0.5 ppm. This technique is required to obtain ^{60}Co/^{58}Co activities differing only by one order of magnitude. In this way it also was possible to determine the thermal/fast neutron fluxes at the different irradiation places in BR-1. From the experimental results of the calibration curves it appeared that even for the lowest concentration range the standard deviation did not exceed 12%. (auth)

5829 DETERMINATION OF Cu, Zn AND Mn IN COBALT METAL BY ACTIVATION ANALYSIS. A. Speecke and K. Maes (Studiecentrum voor Kernenergie, Mol, Belg.). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/5, 12p. (CONF-641001-2)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

Activation analysis was chosen as an independent check on the accuracy of the determination of Cu, Zn, and Mn in high-purity cobalt from an industrial laboratory. The determination of Cu, Zn, and Mn down to 10, 10, and 1 ppm, respectively, is described. In order to separate the desired activities from the cobalt, careful chemical procedures were established by tracer studies. Irradiations were performed in solution. Standards were made up by adding known amounts of the impurities to cobalt, and afterwards underwent the same procedures as the samples to be analyzed. The ^{69}Zn(T/2 = 13.8 h) and ^{56}Mn-(T/2 = 2.58 h) activities were integral γ counted, whereas for ^{64}Cu(T/2 = 12.8 h) the 511 kev β^+-annihilation radiation was selectively measured. The decay of these activities was followed for several half lives, so as to correct for long-living species, such as ^{65}Zn and residual ^{60}Co. The interferences caused by other impurities present in the cobalt metal were investigated and the chemical separations and measuring techniques adjusted, if necessary. Changes in neutron flux were corrected by measuring the ^{60}Co activity in a separated fraction. The results obtained have excellent reproducibility and compare very well with those obtained by the independent laboratory. (P.C.H.)

5830 TRACE ELEMENT CONTENTS IN MARBLES WORKED BY THE ANCIENT GREEKS. L. Rybach and H.-U. Nissen (Eidgenossische Technische Hochschule, Zurich). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/15, 17p. (CONF-641001-1)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

In the course of a trace element determination by means of x-ray spectroscopy the Na and Mn contents of 250 specimens from quarries in the Aegean Islands, Attica, Greece, and western Anatolia, Turkey, were analyzed using neutron activation. Rock fragments having approximately the shape of a slice about 1 cm diameter and 0.5 cm thick were broken directly out of the core parts of hand specimens carefully avoiding weathered parts near the surface or joints. They were then activated 24 hours with 3.6×10^{12} slow neutrons/cm^2 sec and γ spectra of ^{24}Na and ^{56}Mn, respectively, were measured using an RCL 512-channel analyzer. The trace element contents were low but highly characteristic. Mn contents vary between 3 and 10 ppm, contents of 30 to 50 ppm are rare. Contents around 100 ppm only occur in rocks containing much dolomite. The Na contents vary from about 1 ppm to 80 ppm; specimens with higher contents occur rarely. Samples from the same hand specimen have almost identical Na and Mn contents and those from nearby quarries have a similar range. The Mn in calcite probably substitutes for Ca in the calcium carbonate. The Mn contents determined by x-ray spectroscopy were in good agreement with the values obtained by neutron activation analysis. (P.C.H.)

5831 ANALYSIS OF TRACE AMOUNTS OF CHROMIUM IN MARINE ORGANISMS BY THE ISOTOPE DILUTION OF CHROMIUM-51. R. Fukai (International Atomic Energy Agency, Monaco). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/10, 21p. (CONF-641001-16)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

The isotope dilution technique of chromium-51 was applied to the determination of trace amounts of chromium in marine organisms. To establish the complete procedure of analysis the recovery and purity of chromium were checked step by step by using chromium-51 and other radioisotopes of interfering elements as tracers. On the basis of check experiments the whole procedure was arranged as follows: to dried samples of marine organisms which contain 1-2 g of ash material, 1-2 μC of chromium-51 of known specific activity are added and dry-ashed at 550°C. The ash is dissolved with hydrochloric acid and the solution is heated to change all chromium into trivalent form. To separate chromium from a large amount of calcium, magnesium, sodium, and potassium, chromium is precipitated with iron and aluminum as hydroxide. The mixed hydroxides are ignited and fused with sodium carbonate and potassium nitrate in order to oxidize all trivalent chromium to hexavalent. Chromate is taken into solution and transformed to perchromate with hydrogen peroxide and extracted with ethyl acetate. Chromium is then back-extracted from organic phase with potassium hydroxide solution to aqueous phase. These procedures purify chromium free from metallic interfering elements. The specific activity of separated chromium is measured by counting the gamma rays of the solution by scintillation well counter and by determining chromium content of the solution by the spectrophotometric method with diphenyl carbazide. Recovery of chromium through the whole procedure is between 70 and 80%. By changing the valency state of chromium several times in the procedure the decontamination of interfering elements is achieved. By applying this technique, the overall error of analysis is estimated to be less than 20% for the quantities of microgram order. (auth)

5832 DETERMINATION OF TRACES OF IMPURITIES IN URANIUM BY MEANS OF ACTIVATION. A. Travesi and J. A. Galiano (Junta de Energia Nuclear, Madrid). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/84, 19p. (CONF-641001-12). (In Spanish)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

Activation analysis using reactor neutrons (JEN-1) was applied to determining traces of chromium, manganese, cobalt, and copper in uranium samples. By combining

chemical and gamma-spectrometry separation techniques it was possible to determine the amounts of these elements without interference from fission products and with sensitivities of better than 1 ppm, even in the worst cases. The radiochemical methods developed include coarse initial separation by precipitation, followed by purification using liquid-liquid extraction; in this way very satisfactory decontamination is obtained in a relatively short time. The results were compared with those obtained earlier with the same samples using other analytical techniques (colorimetry, polarography, and emission spectrography, and excellent agreement was found. (auth)

5833 THE DETERMINATION OF TANTALUM AND TUNGSTEN IN NIOBIUM BY MEANS OF RADIOACTIVATION ANALYSIS. E. Preisler (Max-Planck-Institut fur Metallforschung, Stuttgart) and H. Staerk. Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/39, 19p. (CONF-641001-9)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

Tantalum and W were determined in Nb without any chemical separation by activity measurement at two different gamma energy levels. The determination must be performed very exactly, because only small variations of the concentration of these elements in zone-melted niobium steels should be examined. The homogeneous activation of many samples, the resonance activation, the geometry of the irradiation samples, the preparation of standards, and the influence of the matrix were investigated thoroughly. The method was also proved by analyzing samples of the AGARD project. (P.C.H.)

5834 RAPID DETERMINATION OF SILVER IN LEAD BY NON-DESTRUCTIVE NEUTRON ACTIVATION ANALYSIS. W. Recke (Univ. of Concepción, Chile) and H. Sorantin. Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/100, 13p. (CONF-641001-21)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

For the determination of silver in lead the hard β rays of the 24-sec ^{110}Ag were measured. Because of the high self-absorption of lead, samples of infinite source thickness and internal standards were applied. After suppressing the interfering 0.62-Mev betas of ^{209}Pb by an adsorber, a linear proportionality of counting rates and silver content was reached in a range of 1 to 50 ppm. The amount of silver in lead of different origin was examined. (auth)

5835 DETERMINATION OF TIN IN TIN ORES BY RADIOISOTOPE X-RAY FLUORESCENCE. J. R. Rhodes, T. G. Ahier, and I. S. Boyce (Wantage Research Lab., Berks, Eng.). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/20, 27p. (CONF-641001-47)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

The determination of tin in tin ores was used as a typical example to illustrate the potentialities of two different applications of radioisotope x-ray fluorescence in ore analysis. The first is routine continuous analysis in process streams with emphasis on high sensitivity. A novel arrangement of primary exciting source and target was developed which emits monochromatic radiation whose energy is optimum for exciting tin fluorescent x rays with minimum scattered background. Results with this arrangement show that a considerable increase in sensitivity can be obtained over normal methods employing direct excitation of fluorescent x rays with x-ray sources. The use of source-target combinations in the way described is quite general and not confined to determination of tin concentration. The second application is rapid assay of elements of interest in ore veins at proposed working points in mines using a newly developed Isotope Portable Analyser. (auth)

5836 THE HISTORICAL BACKGROUND OF SOME APPLICATIONS OF ISOTOPIC TRACERS IN ANALYTICAL CHEMISTRY. G. de Hevesy (Univ. of Stockholm). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/1, 18p. (CONF-641001-10)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

The historical background of the first application of radioactive tracers is discussed. Furthermore, the historical background of the introduction of the principle of isotope dilution and of that of activation analysis is included. (auth)

5837 THE MICROASSAY OF VITAMIN B-12 IN HUMAN PLASMA BY THE SATURATION ASSAY TECHNIQUE. R. P. Ekins and A. M. Sgherzi (Middlesex Hospital, London). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/83, 20p. (CONF-641001-13)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

The assay of vitamin B-12 in human plasma by saturation analysis is described. ^{57}Co-labeled vitamin B-12 of relatively high specific activity was used. The fundamental principles of assays of this type are briefly discussed with particular reference to the selection of optimal conditions to maximize their precision. The way in which the concentrations of binding protein and of labeled vitamin influence the sensitivity of the assay is indicated. Experiments were initially conducted to measure accurately by this technique the specific activity of the labeled vitamin supplied. A value lower than that specified by a factor of more than three was observed, and further experiments carried out to verify this result are described. These included the assay of segments of chromatograms on which quantities of vitamin B-12 of the order of a millimicrogram had been run. It was thus hoped to detect the possible presence of unlabeled B-12 analogues in the tracer solution supplied which might simulate vitamin B-12 in the assay technique. A slight modification enables the assay to be conducted without a precise knowledge of the specific activity or chemical purity of the tracer and is included in what is now regarded as the definitive method. The various experiments carried out to validate the procedure are described, and the results obtained when the sera from patients and normal controls were assayed are reported. (P.C.H.)

Inorganic and Physical Chemistry

5838 (AD-450679) MASS SPECTROMETRIC STUDY OF THE OXIDATION OF TUNGSTEN. Technical Report No. C-26. P. O. Schissel and O. C. Trulson (Union Carbide Corp. Research Inst., Tarrytown, N. Y.). Oct. 1964. Contract DA-30-069-ORD-2787. 24p.

A mass spectrometer has been used to study the kinetics of the oxygen-tungsten reaction over the temperature range 1400°K to 3150°K at oxygen pressures as high as 2×10^{-4} torr. The main products of chemical reaction are identified as W_3O_9, W_2O_6, WO_3, and WO_2; their intensities are given as a function of surface temperature and oxygen pressure. At high surface temperatures, atomic oxygen is observed in an abundance comparable to the impingement rate of molecular oxygen on the surface. These observations lead to a reaction mechanism involving two types of oxygen on the surface, the first tightly bound with a desorption energy near 144 kcal/mole, the second more loosely bound with a desorption energy near 114 kcal/mole. A detailed kinetic model is proposed to account for the observations. (auth)

5839 (CEA-R-2435) DISSOCIATION ELECTROLYTIQUE DE NH_2K DANS NH_3 LIQUIDE. (Electrolytic Dissociation of NH_2K in Liquid Ammonia). Fernande Botter (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). Aug. 1964. 24p.

By assuming the Debye and Huckel approximation giving the activity coefficient and the Onsager relationship linking the conductivity and infinite dilution conductivity of an electrolyte, it has been possible using the available literature data and electrical conductivity measurements, to calculate certain typical parameters of the dissociation of potassium amide in liquid ammonia in the temperature range of −77°C to −33.5°C: degree of dissociation, mean

activity coefficient of the ions NH_2^- and K^+, and the mean activity of these ions. (auth)

5840 (CEA-R-2438) CONTRIBUTION À L'ÉTUDE THERMODYNAMIQUE DES OXYDES NON STOECHIOMETRIQUES UO_{2+x} ET FeO_{1+x}. (Contribution to the Thermodynamic Study of the Non-Stoichiometric Oxides UO_{2+x} and FeO_{1+x}). Paul Gerdanian (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1964. 84p. Dep.(mn).

Thesis submitted to Université, Paris.

This thermodynamic study has provided new results concerning the oxide UO_{2+x} and FeO_{1+x}. For the oxides UO_{2+x}, correct values have been obtained for $\mu_{O_2}^M$ at 900, 1000, and 1100°C using an improved method based on physico-chemical equilibria. For the oxides FeO_{1+x}, the use of an E. Calvet high temperature calorimeter has made it possible to measure for the first time the values of $h_{O_2}^M$ at 800°C over the whole iron monoxide range. The method of oxygen transfer between oxides, usually used to determine the phase limits, has been improved by using a thermobalance; this has made it possible to draw up simple rules which have to be respected in order to detect the phenomena under study. The theory due to J. S. Anderson has been applied to the oxides UO_{2+x} and a new method is given for improving the representation of non-stoichiometric oxides by models. (auth)

5841 (CEA-R-2528) CONTRIBUTION A L'ETUDE DE LA STRUCTURE DES SOLUTIONS SOLIDES ARGENT–KRYPTON. (Contribution to the Study of the Structure of Silver–Krypton Solid Solutions). Viviane Levy, Jacques Hillairet, Jean Delaplace, Jacqueline Antolin-Beaudier, and Yves Adda (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). July 1964. 40p. Dep.(mn).

The silver–krypton solid solutions formed by electrical discharge have been studied by x rays, electrical resistivity, and electronic transmission microscopy. The crystalline parameter and residual resistivity measurements have shown that the krypton atom behaves very differently from those of other elements of the periodic classification when dissolved in silver. The recovery of the crystalline parameter and of the electrical resistivity has been studied as a function of temperature. (auth)

5842 (IA-927) THE SPECTRUM OF Nd I. SOME RESULTS AND REMARKS. S. Held (Israel. Atomic Energy Commission. Soreq Research Establishment, Rehovoth). Mar. 1964. 37p. Dep.(mn).

The Nd(I) spectrum was separated from the spectrum of the higher ionization stages by using only a d-c arc as the excitation source. The Nd(I) lines observed in the 2717.13A-2956.14A and 4499.66A-5501.50A spectral ranges are listed. Many Nd(I) lines were found in this investigation which were not reported by King. Of the lines classified by Hassan and Klinkenberg as Nd(I), some were found to belong to the neutral atom spectrum, some were assigned to the Nd(II) spectrum, and many were not detected at all. (auth)

5843 (JUL-182-PP) CALCULATIONS ON THE TEMPERATURE-SENSITIVE INTENSITY RATIO OF THE He II-4686 Å LINE AND ITS NEIGHBOURING CONTINUUM. H. F. Berg and G. Tondello (Kernforschungsanlage. Institut für Plasmaphysik, Jülich, Germany). Aug. 1964. 13p. Dep.(mn).

The calculation of this intensity ratio has been carried out previously from 80,000°K to higher temperatures. The present calculation extends the method to lower temperatures, where the continua of both the neutral and ionized atoms have to be considered. In this low temperature domain the temperature sensitivity of the intensity ratio is much increased over that of the high temperature range. The absolute intensities of the continua due to the neutral and ionized atoms are presented separately. Finally the intensity ratio of the He II 4686-Å line and its neighboring continuum is plotted and taken out to higher temperatures sufficiently to provide some overlapping points with the previous calculation. Deviations in the states of the ionized atom from the thermal population were considered. For the partition function cutoff the reduced ionization potential was used. (auth)

5844 (ORNL-3720) A COMPUTER PROGRAM FOR CALCULATING OSMOTIC AND ACTIVITY COEFFICIENTS FROM ISOPIESTIC DATA. M. H. Lietzke (Oak Ridge National Lab., Tenn.). Dec. 1964. Contract W-7405-eng-26. 29p. Dep.; $2.00(OTS).

A computer program has been written to calculate osmotic and activity coefficients from isopiestic data. Input to the program consists of the isopiestic molalities of the reference salt and of the substance under investigation. Output consists of the parameters of fit for the substance under investigation, the standard errors in the parameters, and a table of osmotic and activity coefficients computed for an arbitrary list of concentrations. The program is general (for aqueous solutions) and can be used for any electrolyte type at any temperature. A listing of the program is given. (auth)

5845 (ANL-Trans-104) INTERACTION OF GALLIUM CHLORIDE WITH THE CHLORIDES OF LITHIUM, POTASSIUM, AMMONIUM, CESIUM AND THALLIUM. PART I. P. I. Fedorov and V. V. Tsimbalist. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Zh. Neorgan. Khim., 9: 1676-80(1964). 9p. Dep.(mn); $1.00(cy), 1(mn) OTS; $1.10(fs), $0.80(mf) JCL.

The state diagrams of binary systems consisting of gallium chloride with lithium, potassium, ammonium, cesium, and thallium chloride have been studied by means of the method of thermal analysis. In the system with lithium chloride, an incongruently melting compound $LiGaCl_4$ had been detected. In all other systems, two compounds of the composition $MGaCl_4$ and MGa_2Cl_7 have been found. The compounds of the first type melt congruently where their stability increases with an increase of the ionic radius of the cation at the transition from potassium to cesium. The compound KGa_2Cl_7 melts congruently; the other compounds of this type melt incongruently. (auth)

5846 (ANL-Trans-105) THE INTERACTION OF GALLIUM CHLORIDE WITH THE CHLORIDES OF ZINC, CADMIUM AND MERCURY. P. I. Fedorov, V. V. Tsimbalist, and Go-Yuan Lyu. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Zhur. Neorgan. Khim., 9: 1691-3(1964). 5p. Dep.(mn); $1.00(cy), 1(mn) OTS; $1.10(fs), $0.80(mf) JCL.

Thermal analysis was applied to the study of the state diagrams of binary systems consisting of gallium chloride and chlorides of zinc, cadmium, and mercury. Alloys with a zinc chloride content of above 25 mole % form glasses. In systems with cadmium and mercury chloride compounds, chlorogallates of the composition $M(GaCl_4)_2$ have been detected. Cadmium chlorogallate decomposes according to a peritectic reaction at 192°C, whereas mercury chlorogallate melts congruently at 77°C. (auth)

5847 VISCOSITY COEFFICIENTS OF $N_2^{14}-N_2^{15}$ AT 78 TO 300°K. N. E. Menabde. At. Energ. (USSR), 17: 307-8(Oct. 1964). (In Russian)

The viscosity coefficients of $^{14}N_2$ and $^{15}N_2$ were determined at about 22 mm Hg pressure in the temperature range 78 to 300°K, using a vibrating-disk viscosimeter. Results are presented, and the variation of the ratio of the viscosity coefficients with temperature is observed. The collision diameter of a molecule with low energy and the ratio of the potential-well depth to the Boltzmann constant, for the Lennard-Jones intermolecular potential, are calculated and compared for the two isotopes. (M.J.T.)

5848 THE PREDICTION OF METAL-TO-METAL BONDING IN TRANSITION METAL BINARY AND RELATED COMPOUNDS. J. C. Sheldon. Australian J. Chem., 17: 1191-6(1964).

The evidence for, and the factors determining, the formation of metal-to-metal (m–m) bonds in transition metal oxides, sulfides, halides, and related complexes are discussed. It is proposed that when metals of high

preferred valence state are constrained to low formal oxidation states, m–m bonds will form to allow the metal to exercise a higher valency. It is assumed that (n–1)d orbitals are used for such bonds and predictions of the feasibility of m–m bonding are possible by the comparison of the size of such orbitals with the expected inter-metal distances in polymeric metal oxides and halides. It is concluded that binary oxides and halides (excepting fluorides) of the lower oxidation states of Zr, Hf, Nb, Ta, Mo, W, and Re and a few neighboring elements will display m–m bonds. (auth)

5849 NOTE ON THE PROTON RESONANCE SPECTRA OF H_2S AND HSD. Hubert Schmidbaur and Walter Siebert (Universität, Marburg, Ger.). Chem. Ber., 97: 2090-1(1964). (In German)

Saturated and dilute solutions of H_2S in pure CS_2 show a sharp proton signal at 35 ± 2°C whose position is practically independent of concentration at low levels. To determine the spin-spin interaction, HSD was synthesized from Al_2S_3 and H_2O/D_2O 5:95 (v/v); the mixture of HSD and D_2S was practically free of H_2S. It gave the expected spectrum in CS_2. The singlet signal of H_2S did not coincide with the middle signal of the HSD triplet but with the side band at lower field. The values were H_2S τ = 9.283; HSD, τ = 9.316; $\Delta\tau$ = 0.033; J_{HSH} = 13.3; J_{HSD} = 2.0. The isotope shift $\Delta\tau$ is unusually large, and exceeds all known values for geminal H/D substitution. The values above are compared with literature values, where they exist, for H_3P and HPD_2, and H_4Si and $HSiD_3$; good agreement is found for J values in the S and P compounds ascribable to the bonding similarity, which is also reflected in the bond length and bond angle. Different results for the Si compounds exist reflecting different hybridization. The isotope effect for H_3P/HPD_2 is one-eighth that for the S compounds. (BBB)

5850 EXISTENCE AND STRUCTURE OF A M_2C PHASE IN YTTRIUM RARE EARTH–CARBON SYSTEMS. Guy Dean, Robert Lallement, Robert Lorenzelli, and Roger Pascard. Compt. Rend., 259: 2442-4(Oct. 12, 1964). (In French)

In all the M–C systems studied, where M = Gd, Dy, Ho, Er, and Y, the examination with x rays reveals a new phase, common to all these systems, which appears to be a superstructure of the well-known, face-centered-cubic monocarbide phase. The superstructure rays have the maximum in definition and intensity for the composition M_2C. M_2C has a unit cell parameter double that of the primitive face-centered-cubic unit cell with a slight rhombohedric deformation. (tr-auth)

5851 THE TETRAHYDRATES OF RARE EARTH AND YTTRIUM PERRHENATES. V. E. Plyushchev and M. B. Varfolomeev (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 158: 664-7(Sept. 21, 1964). (In Russian)

Large crystals of $Me(ReO_4)_3 \cdot 4H_2O$ were isolated by adding $HReO_4$ to the rare earth oxide (Me_2O_3) and evaporating the solution at 80°C. The crystals separated out with a yield of 95% on cooling the solution to 20°C. The crystal composition was determined by analyzing for Me_2O_3 and Re_2O_7. The water content was determined by difference. The densities of the compounds increased from 4.445 g/cm³ for $La(ReO_4)_3 \cdot 4H_2O$ to 4.755 g/cm³ for $Lu(ReO_4)_3 \cdot 4H_2O$. The density of the yttrium compound $Y(ReO_4)_3 \cdot 4H_2O$ was found to be 4.262 g/cm³. The refractive indices of these compounds are listed. A thermogravimetric study of the compounds showed that the tetrahydrate goes to the monohydrate in the series from La to Gd, and to the dihydrate in the series from Tb to Lu (and Y). The anhydrous compounds melted at 865 to 905°C. A polymorphic conversion of the anhydrous rare earth perrhenate was observed at 580 to 620°C with terbium and rare earths of higher atomic weight. (TTT)

5852 HEAT CONDUCTIVITY OF SCANDIUM NITRIDE. V. S. Neshpor and G. V. Samsonov (Inst. of Problems in Metallography, Academy of Sciences, Ukrainian SSR). Depovidi Akad. Nauk Ukr. RSR, No. 9, 1175-7(1964). (In Russian)

The thermal conductivity of scandium nitride with a composition $ScN_{0.98}$, was measured and compared with the values for the thermal conductivity of nitrides of other transition metals. It is shown that the ratio of the electron and lattice part of the thermal conductivity of transition metal nitrides is a function of the acceptor capacity of d-electron sublevels of transition metal atoms. (auth)

5853 CONTINUOUS ELECTROWINNING OF PLUTONIUM FROM CHLORIDE MELTS. Martin H. Curtis and Horace H. Hopkins, Jr. (General Electric Co., Richland, Wash.). Electrochem. Technol., 2: 239-44(July-Aug. 1964). (HW-SA-3046(Rev.)

Continuous electrowinning of plutonium metal from plutonium trichloride was successfully demonstrated in nuclearly safe equipment. Nuclear safety is achieved by restricting the system in a 57-mm-diam envelope. Plutonium metal is produced at the rate of 50 g/hr for 60% cathode current efficiency. A ceramic oxide annular cell permits continuous molten metal product flow. Some oxide may be present in the chloride feed. A barium chloride–potassium chloride melt is used, and operation is at 800°C. Runs over 10 hr duration have been made, and conditions have been established for reliable operation. (auth)

5854 STOICHIOMETRY OF THE REACTION BETWEEN URANIUM(IV) AND CHLORITE. Gilbert Gordon and Frederic Feldman (Univ. of Maryland, College Park). Inorg. Chem., 3: 1728-33(Dec. 1964).

The stoichiometry of the reaction between uranium(IV) and chlorite was studied at room temperature with rapid mixing techniques. Under some conditions, results consistent with the mechanism U(IV) + Cl(III) = U(VI) + Cl(I) (slow), Cl(I) + Cl(III) = Cl(V) + Cl^- (fast), and the over-all reaction U(IV) + 2Cl(III) = U(VI) + Cl(V) + Cl^- were obtained. Analyses were performed on the amount of U(IV) consumed and Cl(V) [i.e., ClO_3^-] produced in the reaction. The value of the $[Cl(III)]/[U(IV)]_{consumed}$ ratio in the absence of scavengers was found to vary from 1.5 to 2.5. With phenol present initially, the second (fast) step was not observed and the $[Cl(III)]/[U(IV)]_{consumed}$ ratio decreased to 1. This was used as evidence that Cl(I) is indeed an intermediate. Kinetic experiments between U(IV) and Cl(I), Cl(III), Cl(IV), and Cl(V) were carried out to obtain further evidence for the proposed mechanism. The results of these studies showed that the relative rates of the reaction between U(IV) and the various halogenates were Cl(III) > Cl(IV) > Cl(I) > Cl_2 > Cl(V). (auth)

5855 THE OXIDATION OF AQUEOUS URANIUM(IV) BY BROMINE. Gilbert Gordon and Arthur Andrewes (Univ. of Maryland, College Park). Inorg. Chem., 3: 1733-7(Dec. 1964).

The reaction between uranium(IV) and bromine was studied in 0.7 to 2.0M perchloric acid at 25°C. The value of the rate constant appropriate to the rate law $-d[U(IV)]/dt = k[U(IV)][Br_2][H^+]^{2-}$ was found to be 5.3×10^{-4} M sec.$^{-1}$ The reaction was markedly catalyzed by Fe(III). Possible mechanisms consistent with the observed rate law are proposed. (auth)

5856 THE REDUCTION OF URANIUM BROMIDE BY MOLTEN ALUMINUM FROM FUSED POTASSIUM BROMIDE–ALUMINUM BROMIDE MIXTURES. R. H. Moore (General Electric Co., Richland, Wash.). Inorg. Chem., 3: 1738-40(Dec. 1964). (HW-80011)

The reduction of UBr_3 from its solutions in molten KBr-$AlBr_3$ by molten aluminum gave dilute uranium-aluminum alloys by an equilibrium-controlled reaction. The position of the equilibrium was much less favorable for reduction of uranium than the analogous chloride system. In the transition from a pure chloride system to a pure bromide system the position of the equilibrium did not change uniformly but exhibited a marked shift favoring reduction to uranium at low bromide ion concentrations. These phenomena were interpreted in terms of complex ion formation. (auth)

5857 REACTIONS OF XENON HEXAFLUORIDE WITH ANTIMONY PENTAFLUORIDE, HYDROGEN CHLORIDE,

AMMONIA, AND PERFLUOROCYCLOPENTENE. Gary L. Gard and George H. Cady (Univ. of Washington, Seattle). Inorg. Chem., 3: 1745-7(Dec. 1964).

By varying the proportions of the reactants, antimony pentafluoride and xenon hexafluoride, it was possible to prepare each of the crystalline solids: $XeF_6 \cdot 2SbF_5$, $XeF_6 \cdot SbF_5$, $SbF_5 \cdot 2XeF_6$. Hydrogen chloride, ammonia, and perfluorocyclopentene reacted readily with xenon hexafluoride but the products were not found to include substances in which xenon is in combination with chlorine, nitrogen, and carbon, respectively. (auth)

5858 SAMARIUM AND LANTHANUM TUNGSTATES OF THE $3R_2O_3 \cdot WO_3$ TYPE. Luke L. Y. Chang and Bert Phillips (Tem-Pres Research, Inc., State College, Penna.) Inorg. Chem., 3: 1792-4(Dec. 1964).

The compounds $3Sm_2O_3 \cdot WO_3$ and $3La_2O_3 \cdot WO_3$ were prepared and the possibility of a solid-solution series between the two compounds studied. The compounds were both very refractory. Differential thermal analysis showed no heat effect in either compound. Both compounds lost oxygen when heated above 800°C. Crystallographic properties were determined from x-ray powder diffraction patterns. (M.C.G.)

5859 THE RELATIVE STABILITIES OF NOBLE GAS COMPOUNDS. Ricardo Ferreira (Indiana Univ., Bloomington). Inorg. Chem., 3: 1803-4(Dec. 1964).

It is shown that chemical evidence suggests that some argon compounds may be more stable than the corresponding compounds of krypton and, therefore, that there is a fair prospect of coaxing argon into forming relatively stable compounds. The oxygen compounds of argon are expected to be more stable than corresponding krypton compounds. (M.C.G.)

5860 ZIRCONIUM. Warren B. Blumenthal. Intern. Sci. Technol., No. 35, 27-31(Nov. 1964).

The chemistry of Zr is discussed. Complexing, reactions, and bonding of Zr are included. (P.C.H.)

5861 QUANTUM FLUIDS. I. M. Khalatnikov. Intern. Sci. Technol., No. 35, 60-2; 64; 66; 68; 70(Nov. 1964).

The unusual things that happen to liquid helium when it is cooled below 2.18°K and the present understanding of why those things happen are discussed. (P.C.H.)

5862 COMPOUNDS OF THE CERIUM SUB-GROUP ELEMENTS CONTAINING SELENIUM AND TELLURIUM. E. I. Yarembash, E. S. Vigileva, A. A. Eliseev, and V. I. Kalitin (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1306-9(Aug. 1964). (In Russian)

The chalcogenide was formed directly by heating the elements in a quartz vessel under vacuum or purified argon. A preliminary phase diagram is given for the La–Te system, which was investigated up to a temperature of 1000°C in the region of 50 to 100 at. % Te. The lathanum tellurides LaTe, La_3Te_4, La_2Te_3, La_4Te_7, $LaTe_2$, La_2Te_5(?), and $LaTe_3$ were detected. The compounds PrSe, Pr_3Se_4, Pr_2Se_3, Pr_4Se_7, and $PrSe_2$ were found in the Pr–Se system. The electric conductivity at 20 and 170°C, the thermal emf, and width of the forbidden zone $\Delta E_{opt.}$ were determined on pressed samples of La_2Te_3, Ce_2Te_3, Pr_2Te_3, Nd_2Te_3, and Sm_2Te_3. The electrical conductivity varied from 4.5 $ohm^{-1}\,cm^{-1}$ for Nd_2Te_3 at 170°C to 5×10^{-4} $ohm^{-1}\,cm^{-1}$ for La_2Te_3 at 20°C. The thermal emf α was 30 to 40 $\mu v\ deg^{-1}$ at 20°C. Most of the tellurides showed n-type conduction. The width of the forbidden zone was 1.2 to 1.5 ev (20°C). The electric conductivities of the selenium compounds were lower than the electrical conductivities of the corresponding tellurium compounds. Single crystals of $LaTe_2$ and Nd_2Se_3 were grown, and the properties of these crystals are compared with the properties of the polycrystalline material. (TTT)

5863 CHROMATOGRAPHIC SEPARATION OF ISOTOPIC METHANES. P. L. Gant and K. Yang (Continental Oil Co., Ponca City, Okla.). J. Am. Chem. Soc., 86: 5063-4 (Dec. 5, 1964).

Isotopic methanes were separated chromatographically by using a charcoal column (−3.5 to 150°C). Retention times progressively decreased with increasing D or T substitutions. This decrease was consistent with the expected decrease in polarizabilities with increasing D or T substitutions. (auth)

5864 THE PHOTOCHEMISTRY OF URANYL OXALATE. D. H. Volman and J. R. Seed (Univ. of California, Davis). J. Am. Chem. Soc., 86: 5095-8(Dec. 5, 1964).

The photolysis of aqueous solutions of uranyl oxalate-oxalic acid was studied at various intensities, wave lengths, temperatures, concentrations, and acidities. The results were interpreted by the stoichiometrical relations: (1) $H_2C_2O_4 \rightarrow CO + CO_2 + H_2O$; (2) $H_2C_2O_4 \rightarrow CO_2 + HCOOH$; and (3) $U^{6} + H_2C_2O_4 \rightarrow 2CO_2 + 2H^+ + U^4$. The fraction of decomposition attributable to each pathway was found to be independent of intensity, wave length, and temperature and to depend on concentration and acidity. Quantum yields of gaseous product formation were evaluated for various experimental conditions. Mechanisms for (1) and (2) are given using the simplest uranyl complexes, $UO_2(HC_2O_4)^+$ and $UO_2(C_2O_4)$. For (3) a mechanism is given that accounts for the products by single electron-transfer steps and disproportionation of U^V to U^{IV} and U^{VI}. (auth)

5865 THE ARGON-DEUTERIUM HYDRIDE ION REACTION. M. A. Berta and W. S. Koski (Johns Hopkins Univ., Baltimore). J. Am. Chem. Soc., 86: 5098-5101 (Dec. 5, 1964).

Reactions of HD^+ with argon were studied using a tandem mass spectrometer. In the first two reactions, attention was centered on the isotope effect, and the ratio ArH^+/ArD^+ between 2 and 25 ev varied from 1.3 to 1.9, respectively. In the charge-transfer reaction, the cross section was measured from 2 to 70 ev, and indications were obtained that the reacting HD^+ ions were in vibrationally excited states. (auth)

5866 SYNTHESIS AND FLUORESCENCE OF SOME TRIVALENT LANTHANIDE COMPLEXES. L. R. Melby, N. J. Rose, E. Abramson, and J. C. Caris (E. I. du Pont de Nemours & Co., Wilmington, Del.). J. Am. Chem. Soc., 86: 5117-25(Dec. 5, 1964).

Some trivalent lanthanide complexes were prepared. They include tris(β-diketone) chelates complexed with bidentate ligands of the phenanthroline type, and with N- and P-oxide donors. Of particular interest is a broad class of anionic tetrakis(β-diketone) derivatives, which are believed to be eight-coordinate. Well-resolved fluorescence emission spectra of several europium complexes were recorded. (auth)

5867 OCTACOORDINATE CHELATES OF LANTHANIDES. TWO SERIES OF COMPOUNDS. Herbert Bauer, Joseph Blanc, and Daniel L. Ross (RCA Labs., Princeton, N. J.). J. Am. Chem. Soc., 86: 5125-31(Dec. 5, 1964).

Two series of compounds of the compositions $C^+[(\beta\text{-diketono})_4Ln(III)]^-$ and $(\beta\text{-diketono})_3BLn(III)$ are reported in which C^+ is a substituted ammonium cation, B is a neutral bidentate ligand, and Ln is Eu, Gd, or Tb. Methods of preparation and physical properties, including fluorescence spectra, are presented. Chemical and spectroscopic evidence indicated that the eight oxygens in the tetrakis(β-diketono) chelates are essentially equivalent and that the lanthanide ions in these compounds are octacoordinate. (auth)

5868 SECONDARY ISOTOPE EFFECTS IN SOLVOLYSIS OF VARIOUS DEUTERATED BENZHYDRYL CHLORIDES. A. Streitwieser, Jr., and H. S. Klein (Univ. of California, Berkeley). J. Am. Chem. Soc., 86: 5170-3 (Dec. 5, 1964).

Solvolysis kinetics were determined for various deuterated benzhydryl chlorides in 80 and 70% aqueous acetone at 25.00°C. Ring deuteriums caused rate accelerations of the following magnitude per D: ortho, 1.9%; meta, 1.5%; para, 1.0%. These unusual positional effects are discussed, but no unambiguous interpretation was possible. Benzhydryl-α-d

chloride showed a normal α-D rate depression of 12%. (auth)

5869 ANALYSIS OF NMR SPECTRA BY LEAST SQUARES. S. Castellano and A. A. Bothner-By (Mellon Inst., Pittsburgh). J. Chem. Phys., 41: 3863-9(Dec. 15, 1964).

An iterative method for the least-squares analysis of an observed high-resolution NMR spectrum is described. The method is applicable even if all lines are not assignable, is not affected by symmetry in the hamiltonian, yields an estimate of the ellipsoid of error, and converges relatively rapidly to a predetermined assignment. A computer program based on this method is described. Effectively infinite chemical shift may be introduced permitting the analysis of ABXY, etc., spectra. An illustration of its application to the analysis of the proton spectrum of 2-benzoylpyridine is given. (auth)

5870 THE EFFECT OF PRESSURE ON THE ELECTRICAL CONDUCTIVITY OF AQUEOUS, MIXED ELECTROLYTE SOLUTIONS. R. A. Horne and R. A. Courant (Arthur D. Little, Inc., Cambridge, Mass.). J. Chem. Soc., 3548-53(Oct. 1964).

The electric conductivities of aqueous, mixed electrolytic solutions of KCl–HCl and $SrCl_2$–HCl of total concentration 0.10m were measured at 25°C as functions of the relative concentrations of the constituent electrolytes and of hydrostatic pressure over the pressure range 1 to 6700 bars. Conductance equations, such as the Onsager-Fuoss relationship, based on considerations of the electrophoretic and relaxation effects, are not applicable to protonic conduction; therefore the several trends exhibited by the observed mixture effects are discussed qualitatively. Of these trends the most interesting is a reversal of the effect at about 1300 bars. (auth)

5871 THE FAR-ULTRAVIOLET ABSORPTION SPECTRUM OF $^{18}O_2$, $^{17}O^{18}O$, AND $^{16}O^{18}O$. M. Halmann (Weizmann Inst. of Science, Rehovoth, Israel). J. Chem. Soc.: 3729-33(Oct. 1964).

The Schumann-Runge bands of $^{18}O_2$, $^{17}O^{18}O$, and $^{16}O^{18}O$ in the 1800 to 1950 Å region were measured under moderate resolution. Frequency shifts of the vibrational absorption band-heads and rotational lines are consistent with theoretical expectations. The intensity of the absorption bands of $^{18}O_2$ is two-thirds that of the corresponding bands of $^{16}O_2$. The spectrum of oxygen gas in the 1900 Å region can be used to determine its isotopic composition when the oxygen-18 concentration is high. (auth)

5872 HYDROLYSIS OF PHOSPHORYL CHLORIDE IN OXYGEN-18-ENRICHED WATER. M. Halmann and L. Kugel (Weizmann Inst. of Science, Rehovoth, Israel). J. Chem. Soc.: 3733-35(Oct. 1964).

Phosphoryl chloride, dissolved in a large volume of water enriched in oxygen-18, underwent hydrolysis to orthophosphoric acid containing three-quarters of the oxygen-18 excess of the water. Thus, none of the three stages $POCl_3 \xrightarrow{H_2O} Cl_2PO{\cdot}OH \xrightarrow{H_2O} ClPO(OH)_2 \xrightarrow{H_2O} H_3PO_4$ involved fast reversible formation of an intermediate in which the entering oxygen atom from the water became equivalent to the phosphoryl oxygen atom. The first stage was checked by partial reaction of phosphoryl chloride with oxygen-18-enriched water; the unreacted phosphoryl chloride had not become enriched in oxygen-18. (auth)

5873 STABILITY CONSTANTS AND SPECTRA OF SOME LANTHANIDE COMPLEXES. J. C. Barnes (Inorganic Chemistry Lab., Oxford). J. Chem. Soc.: 3880-5 (Oct. 1964).

Formation constants for some europium(III) complexes are reported from measurements on spectra assigned to ligand-to-metal charge transfer. Similar spectra were observed in samarium, thulium, and ytterbium complexes. The spectrophotometric association constants for the monosulphates of the trivalent lanthanides were compared with literature values obtained by other techniques, to estimate the formation of inner and outer sphere complexes. (auth)

5874 KINETIC STUDIES OF THE OXIDATION OF IODINE WITH CERIC SULFATE. [PART] I. Kuan Pan and Schoen-nan Chen (National Taiwan Univ., China). J. Chinese Chem. Soc. (Taiwan), 11: 71-83(June 1964).

The oxidation of iodine by ceric sulfate in sulfuric acid solution was found to be of second-order with respect to iodine and first-order with respect to Ce(IV), by spectrophotometric measurements. $CeSO_4^{2+}$ was assumed to be the active species of ceric sulfate. The over-all rate constants were found to be $k_0 = 2.66 \times 10^4$ l²/M² · min for the reaction rate, $-d[I_2]/dt = k_0[Ce(IV)][I_2]^2$ in 1.0M H_2SO_4 and $k'' = 1.12 \times 10^5$ l²/M² · min for the reaction rate, $-d[I_2]/dt = k''[CeSO_4^{2+}][I_2]^2$. (auth)

5875 THE DENSITY AND SURFACE TENSION OF MOLTEN FLUORIDES. II. THE SYSTEM NaF–LiF–ZrF_4. G. W. Mellors and S. Senderoff (Union Carbide Corp., Parma, Ohio). J. Electrochem. Soc., 111: 1355-7 (Dec. 1964).

Earlier studies of the surface tension of the system KF–LiF–ZrF_4 were extended to the system NaF–LiF–ZrF_4. As was noted previously, plots of surface tension vs log concentrations of ZrF_4 give a series of straight lines with inflection points at concentrations corresponding to the stoichiometry of complex compounds in the liquid. The strength of complexes in the latter system was found to be less than that in the former, and the complex ion $[ZrF_5]^{-1}$, while present in the former, was observed in the latter. The ZrF_7^{-3} ion exists in solution in both systems. (auth)

5876 THE COMPRESSIBILITY OF SOLID NOBLE GASES AND THE ALKALI METALS AT 0°K. Aristid V. Grosse (Temple Univ., Philadelphia). J. Inorg. Nucl. Chem., 26: 1801-9(Nov. 1964).

The compressibilities of the solid noble gases at 0°K (and 0 pressure) were calculated from their experimental and theoretical compressions ($\Delta V/V_0$). They were compared with the experimental values of compressibilities of the alkali metals, also at 0°K. The compressibilities of the noble gases followed an unusual pattern, different from all other families in the Periodic System. The values of the latter were essentially proportional to the atomic volume and therefore the atomic number of the element. Solid helium was by far the most compressible element, to be followed by solid neon; on the other hand Kr, Xe, and Rn were substantially less compressible than the alkali metal directly following them. Ar had practically the same compressibility as K. (auth)

5877 URANIUM TRIOXIDE AND THE UO_3 HYDRATES. V. J. Wheeler, R. M. Dell, and E. Wait (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Inorg. Nucl. Chem., 26: 1829-45(Nov. 1964).

The preparations and characterization of five crystalline polymorphs of UO_3(α, β, γ, δ, ζ) as well as of amorphous UO_3 and $UO_{2.9}$ are described. A detailed x-ray study was made of phases formed during the thermal decomposition of amorphous and β-UO_3. Amorphous UO_3 lost oxygen to form $UO_{2.94}$ at 450°C; this exhibited either the hexagonal structure of α-UO_3 or the orthorhombic structure of $UO_{2.9}$, depending upon the decomposition conditions. Further decomposition led to U_3O_8 in air and $UO_{2.6}$ in vacuum. β-UO_3 decomposed directly to U_3O_8 or $UO_{2.6}$. The UO_3–H_2O system was investigated and an attempt made to rationalize the hydrate phases described previously. Each of the UO_3 phases was hydrated under a range of conditions, and five different hydrates were identified crystallographically: $UO_3 \cdot 2H_2O$, three forms of $UO_3 \cdot H_2O$ and $UO_3 \cdot 0.5H_2O$. The decomposition of each was studied and the UO_3 products identified. The application of further experimental techniques (D.T.A., infrared absorption) revealed a still wider range of hydrates. In particular, a second dihydrate (β-$UO_3 \cdot 2H_2O$), prepared from γ-UO_3, had an x-ray pattern indistinguishable from that of α-$UO_3 \cdot 2H_2O$ but decomposed at a lower temperature and showed a distinct infrared spectrum. (auth)

5878 BARIUM POLYURANATES. J. G. Allpress (Univ. of Melbourne). J. Inorg. Nucl. Chem., 26: 1847-51(Nov. 1964).

The compounds of $Ba_2U_3O_{11}$ and BaU_2O_7 were prepared by solid state reactions of U_3O_8 with $BaCl_2$ and $BaUO_4$. The x-ray powder data, infrared spectra, and thermal stability of these compounds are reported. Both compounds are also formed, together with a possible new form of UO_3, during the decomposition of barium uranyl acetate. (auth)

5879 KINETIC STUDIES OF THE FLUORINATION OF URANIUM OXIDES BY FLUORINE. I. THE FLUORINATION OF U_3O_8 AND UO_3. M. Iwasaki (Japan Atomic Energy Research Inst., Tokyo). J. Inorg. Nucl. Chem., 26: 1853-61 (Nov. 1964).

The reactions of U_3O_8 and UO_3 with fluorine were studied in the temperature range from 350 to 440°C with a thermobalance. The overall reaction consisted of two steps. In the first step reaction, these oxides changed to uranyl fluorides and in the second to UF_6. In the case of U_3O_8, the first step reaction influenced the rate of the second step, so that the formation of the UF_6 was slow at first, where an induction period was seen, and finally followed the linear law. The rate of the first step reaction of UO_3 was much faster than the second step, and the great part of the overall reaction followed the linear law. The activation energies of the second step reactions for U_3O_8 and UO_3 were 21.3 and 22.0 kcal/mole respectively. An almost linear relationship was found to exist between the reaction rate and the partial pressure of fluorine. For U_3O_8, the formation rate of UF_6 was nearly proportional to the surface area determined by gaseous adsorption. (auth)

5880 KINETIC STUDIES OF THE FLUORINATION OF URANIUM OXIDES BY FLUORINE. II. THE FLUORINATION OF UO_2. T. Yahata and M. Iwasaki (Japan Atomic Energy Research Inst., Tokyo). J. Inorg. Nucl. Chem., 26: 1863-7(Nov. 1964).

A study was made on the fluorination of UO_2 powder and pellet to UF_6 with gaseous fluorine over the temperature range from 300 to 430°C, using the same experimental method as reported previously. As same as for the reaction of U_3O_8 and UO_3, the overall reaction consisted of two steps. In the first step, UO_2 was converted to UO_2F_2 and in the second the UO_2F_2 was further changed to UF_6. The first step reaction was very rapid in comparison with the second step, which followed the linear law. The activation energies of the second step reaction were determined for the two types of powders, active and inactive UO_2, to be 33.1 and 29.4 kcal/mole respectively. The reaction rates were approximately proportional to the partial pressure of fluorine. (auth)

5881 KINETICS AND MECHANISM OF THE REACTION BETWEEN PLUTONIUM(III) AND CHLORINE IN CHLORIDE SOLUTIONS. A. S. Ghosh Mazumdar and K. P. R. Pisharody (Atomic Energy Establishment, Trombay, India). J. Inorg. Nucl. Chem., 26: 1903-9(Nov. 1964).

Oxidation of plutonium(III) to (IV) by chlorine in chloride solutions followed an apparently first order rate law with respect to both the reactants, and the rate was independent of acidity. At room temperature, and with 0.01M initial plutonium concentration and about 0.025M initial chlorine concentration, the specific reaction rate, k' increased from 0.04 to 2.8×10^{-2} min^{-1}, as the hydrochloric acid concentration of the medium changes from 1.5 to 8.0M. In solutions having constant hydrochloric acid, k' increased linearly at first with initial chlorine concentration and finally approached a limiting value for a given initial plutonium concentration. The limiting values in 7.0M hydrochloric acid with 0.025M of chlorine concentration were 0.6, 1.2 and more than 2.2×10^{-2} min^{-1} respectively with 0.005, 0.01, and 0.02M initial plutonium concentrations. The rate of oxidation was relatively slow at room temperature in chloride-free perchloric acid solutions, while in solutions containing a mixture of hydrochloric and perchloric acids, it was markedly increased by chloride ion concentration for a given total molarity of the acid mixture as well as by the total molarity having a fixed concentration of hydrochloric acid, showing thereby that the rate is influenced both by chloride ions and by the ionic strength of the medium. Thermodynamic quantities of activation at 26°C were calculated from the experimentally determined activation energy of the reaction, the average value of which was 16.0 ± 1.8 kcal/mole. A mechanism is suggested according to which a transient species is assumed to be formed in steady state concentration by the action of Cl_3^- ions on Pu(III) ions, and the rate is determined by the reaction between these transient species and Pu(III) ions. (auth)

5882 PREPARATION AND THERMAL STABILITY OF SOME DIVALENT METAL CHELATE POLYMERS OF β-HYDRONAPHTHAZARIN. R. S. Bottei and D. Quane (Univ. of Notre Dame, Ind.). J. Inorg. Nucl. Chem., 26: 1919-25 (Nov. 1964).

Metal chelate polymers were prepared from β-hydronaphthazarin and the divalent metal ions: cobalt, nickel, lead, copper, and beryllium. The chelates were fine powders, insoluble or very slightly soluble with dissociation in water, ethanol, and benzene. The metal to ligand ratio was one to one for all chelates. The order of thermal stability was: Be > Cu > Ni > Co > Pb. The composition, thermal stability, and infrared spectra of these chelates were compared with the properties of divalent metal chelates of naphthazarin. Several unsuccessful attempts were made to prepare a zinc-β-hydronaphthazarin chelate. (auth)

5883 THE STABILITIES OF COMPLEXES OF THE RARE EARTHS WITH PROPYLENEDIAMINETETRAACETIC ACID. H. M. N. H. Irving and J. P. Conesa (Univ. of Leeds, Eng.). J. Inorg. Nucl. Chem., 26: 1945-57(Nov. 1964).

The stability of the complex, HgY, of mercury(II) with propylenediaminetetraacetic acid (PDTA; H_4Y) was obtained by potentiometric measurements with a mercury electrode, and that of the cadmium complex, CdY, by a competitive reaction. The stabilities of complexes of PDTA with tripositive rare earth cations relative to those of lead, copper, or cadmium were obtained by a polarographic procedure. In conjunction with the experimental value log K_{CdY} = 17.83 it was then possible to derive stability constants for individual rare earths, which were valid for 20°C and μ = 0.1M (KNO_3). The results are discussed in relation to those previously reported for ethylenediaminetetraacetic acid and cyclohexane-1,2-diaminetetraacetic acid, which also exhibited a "break" at gadolinium. (auth)

5884 X-RAY CRYSTALLOGRAPHIC STUDIES ON β-ZrF_4. V. Amirthalingam and K. V. Muralidharan (Atomic Energy Establishment, Trombay, India). J. Inorg. Nucl. Chem., 26: 2038-9(Nov. 1964).

A study was undertaken of the powder and single crystal data on ZrF_4 to determine the unit cell and the space group. It was found that the powder lines could be indexed as orthorhombic with 26 formula units. Single-crystal work, however, revealed that the true cell is monoclinic and the orthorhombic one is a pseudo cell. The cell parameters were found to be a = 15.8, b = 13.7, c = 15.1Å, and β = 107°. (M.C.G.)

5885 ANALYSES OF YTTRIUM SPECTRA. Arthur B. Hook and Matthew P. Thekaekara (Georgetown Univ., Washington, D. C.). J. Opt. Soc. Am., 54: 1445-51(Dec. 1964).

A near automatic method was developed for data handling and analysis in atomic spectroscopy. Plate factors were determined by a least-squares solution of 100 standard lines by using a polynomial up to the fifth degree. Catalogs of predicted lines were made from known energy level schemes, and classifications of new lines are suggested. The method was applied to the visible spectrum of yttrium as produced by electrodeless discharge tubes. A total of 977 lines was measured with an accuracy of 0.005 Å in the wavelength range 4600 to 6400 Å, which is usually masked by oxide bands; 162 of these lines were classified in terms of the known energy level system. (auth)

5886 ON INDIRECT KNIGHT SHIFT AND NMR IN FERROMAGNETIC METALS. PART I. GENERAL FORMULATION AND QUALITATIVE DISCUSSIONS. Toshinosuke

Muto and Syoiti Kobayasi (Tokyo Univ.). J. Phys. Soc. Japan, 19: 1837-49(Oct. 1964).

The Knight shift arising from exchange-polarization of core s-electrons and conduction electrons by d-band electrons in partially-filled bands is calculated, together with the NMR frequency in ferromagnetic metals. NMR absorption in dilute ferromagnetic alloys is also treated. (D.C.W.)

5887 STUDIES OF HYDROGEN VIBRATIONS IN TRANSITION METAL HYDRIDES BY THERMAL NEUTRON TRANSMISSIONS. Masanobu Sakamoto (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Japan, 19: 1862-6(Oct. 1964).

The total cross sections for thermal neutron scattering by hydrogen in Nb, Ta, Ti, and V hydrides were measured as a function of neutron energy. Ti hydrides with various hydrogen concentrations were studied. The effect of neutron inelastic scattering due to the excitation of hydrogen vibrations was observed. The energy levels of the optical vibrations in the hydride lattices were determined. An approximately linear relation between the energies of the optical phonons and the metal-hydrogen distances reported for various hydrides was established. (D.C.W.)

5888 ELECTRON SPIN RESONANCE OF GAMMA-RAY IRRADIATED $NaNO_3$. Kazuo Gesi and Yukio Kazumata (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Japan, 19: 1981(Oct. 1964).

The electron spin resonance of $NaNO_3$ single crystals irradiated with ^{60}Co gamma rays both at room temperature and 77°K was measured. The spectrum for room temperature consists of four sets of lines, each line having a different thermal annealing and optical bleaching behavior. In the specimen at 77°K, a very intense singlet (believed to be due to neutral NO_3 lying in the (111) plane) was observed, together with a number of weak lines. (D.C.W.)

5889 STUDY OF THE VACUUM REDUCTION OF ZIRCONIUM AND HAFNIUM OXIDES. G. Gosse, L. Renucci, Ph. Albert, and P. Lehr. Mem. Sci. Rev. Met., 61: 717-28 (Oct. 1964). (In French)

An electron bombardment furnace with a high vacuum made it possible to prepare zirconium and hafnium by reduction of their oxides. Reduction by carbon, silicon, and aluminum was studied. Carbon reduction led to undesirable evolution of CO. Silicon and especially aluminum were preferable. (auth)

5890 OMEGATRON MASS-SPECTROMETRIC INVESTIGATION OF THE THERMAL DECOMPOSITION OF MOLYBDENUM TRIOXIDE AND TUNGSTEN TRIOXIDE. Masaru Onchi and Isao Kusunoki (Kyoto Univ.). Nippon Kagaku Zasshi, 85: 612-16(Oct. 1964). (In Japanese)

The evolution of gases due to thermal decomposition of molybdenum trioxide and tungsten trioxide in high vacuum was investigated mass spectrometrically at temperatures between 10 and 500°C. The main gaseous species evolved was found to be carbon dioxide and the evolution rate was increased considerably above 200 and 300°C in the case of MoO_3 and WO_3, respectively. Oxygen as a product of pure thermal decomposition of these oxides, however, was not found throughout the temperature range investigated. The electric conductivity of both oxides was measured simultaneously and it was found that the conductivity was increased to a great extent after carbon dioxide evolution. It was concluded that the origin of non-stoichiometry and semiconductivity of these n-type oxides is due to reduction by impurity carbon contained in oxides and not due to pure thermal dissociation accompanying oxygen evolution. (auth)

5891 PARAMAGNETIC RESONANCE LINEWIDTHS IN SOME RARE-EARTH DOUBLE NITRATES. P. L. Scott (Oxford Univ.), H. J. Stapleton, and C. Wainstein. Phys. Rev., 137: A71-4(Jan. 4, 1965).

The paramagnetic resonance linewidth δH was measured at microwave frequencies for the three trivalent rare-earth ions Ce, Nd, and Sm present in small concentrations in $La_2Mg_3(NO_3)_{12} \cdot 24H_2O$. The linewidths appear to be strongly dependent upon the angle θ between the c axis of the crystal and the magnetic field; and in most cases the observed linewidths seem to be reasonably well explained by a simple theory which assumes a spatial distribution of paramagnetic resonance g values throughout the crystal. (auth)

5892 SPIN-LATTICE RELAXATION OF F^{19} IN CaF_2 AT LOW TEMPERATURES. Stephen M. Day, Eizo Otsuka, and Ben Josephson, Jr. (Rice Univ., Houston, Tex.). Phys. Rev., 137: A108-12(Jan. 4, 1965).

Nuclear relaxation caused by paramagnetic impurities was studied, using the system of ^{19}F nuclei in CaF_2. The nuclear spin-lattice relaxation time T_1 was measured at He, H, and N temperatures. The dependence of T_1 on magnetic field at He temperatures consists of two parts: at fields between a few hundred gauss and about 3 kgauss, the dependence is linear; at higher fields it also appears to be linear, but has a steeper slope. Moreover, there is a strong orientation dependence in the He range for a single crystal, and a size effect appears at higher fields. T_1 has only a weak orientation dependence at temperatures above 14°K. The experimental data indicate that T_1 is at a minimum between 14 and 63°K. Employing existing theories, an analysis of the experimental results permits a determination of the field and temperature dependence of the spin-lattice relaxation time ρ of the paramagnetic impurity. The analysis gives $\rho \propto H^{-\frac{1}{2}}T^{-1}$ at He and H temperatures for 300 gauss < H < 3 kgauss. The impurity concentration is calculated to be approximately one part in 10^6 and ρ is calculated to be $\approx 10^{-6}$ sec at 14°K, assuming the impurity to be Fe. (auth)

5893 ELECTRON SPIN RESONANCE OF RARE-EARTH IN THORIUM OXIDE: Yb^{3+} AND Er^{3+}. M. Abraham, R. A. Weeks, G. W. Clark, and C. B. Finch (Oak Ridge National Lab., Tenn.). Phys. Rev., 137: A138-42 (Jan. 4, 1965). (ORNL-P-252)

The paramagnetic resonance spectrum of Yb^{3+} and Er^{3+} in ThO_2 was investigated at 10.5 Bc/sec over the temperature range of 2 to 40°K. Sites of cubic symmetry as well as axial sites due to nearby charge compensation were observed. Both cubic spectra gave isotropic g values with $g = 3.423 \pm 0.001$ for Yb^{3+} and $g = 6.753 \pm 0.005$ for Er^{3+}; these values are in good agreement with the predicted values for Γ_7 doublets. Temperature variation showed that these were the lowest states. For both ions in dilute crystals the linewidth was ≤0.5 gauss, and in heavily doped crystals the linewidth was 3 to 4 gauss. Nearby charge compensation in the Yb^{3+} case produces four sites of trigonal symmetry with [111] axes, while in the Er^{3+} case the preponderant axial site had tetragonal symmetry with three [100] axes. For Yb^{3+}, $g_{||} = 4.772 \pm 0.002$ and $g_{\perp} = 2.724 \pm 0.001$; and one-third the trace of the g tensor was 3.407. For Er^{3+}, $g_{||} = 3.462 \pm 0.003$ and $g_{\perp} = 7.624 \pm 0.005$, and one-third the trace of the g tensor was 6.240. The linewidths obtained for the axial sites were broader than those for cubic sites and varied with angle. Evidence for macroscopic crystalline imperfections was also found. (auth)

5894 ROLE OF MULTIPLE IONIZATION IN THE GENERATION OF DEFECTS IN ALKALI HALIDES BY SOFT X RAYS. J. Sharma and R. Smoluchowski (Princeton Univ., N. J.). Phys. Rev., 137: A259-63(Jan. 4, 1965).

The F coloration in KCl and KBr was studied at liquid nitrogen temperature as a function of wavelength of monochromatic x rays on either side of the K edges of Cl and Br. The coloration on the high-energy side of the edge is higher than the coloration on the low-energy side by a factor of 2.5 for KCl and 1.1 for KBr. This is interpreted as evidence for the importance of multiple ionization in the process of vacancy formation as required by a Varley-type mechanism based on an Auger effect. In KBr, the K-edge coloration discontinuity was studied as a function of radiation dose at 78, 195, and 300°K. At 78°K the discontinuity becomes more pronounced as irradiation proceeds and new vacancies are created. The discontinuity does not show up at 195 and 300°K, presumably because at these temperatures the color-

ation of existing vacancies is the dominating phenomenon. (auth)

5895 X-RAY GENERATION OF COLOR CENTERS IN ZONE-REFINED KCl AND KBr. T. M. Srinivasan and W. D. Compton (Univ. of Illinois, Urbana). Phys. Rev. 137: A264-72(Jan. 4, 1965).

The techniques of zone purification of KCl and KBr crystals are described, and the success of this technique in removing impurities such as hydroxyl ions and divalent cations is demonstrated. A comparison of the defects introduced into zone-purified salts and commercial salts by x irradiation at room temperature and at liquid-helium temperature is given. Studies of the optical bleaching of F, H, and V_K centers by F-band light at liquid-helium temperature gives evidence of the spatial proximity of these centers. (auth)

5896 CHLORIDE-36 DIFFUSION DURING STABLE AND UNSTABLE FLOW THROUGH GLASS BEADS. J. W. Biggar and D. R. Nielsen (Univ. of California, Davis). Soil Sci. Soc. Am., Proc., 28: 591-5(Sept.-Oct. 1964).

The effect of the properties of solution on the mixing occurring in porous material was examined in glass beads using ^{36}Cl. Matched NaCl solutions of 0.01, 0.1, and 4N concentration with either the displacing or displaced solutions identified by ^{36}Cl were displaced from a 30 cm column. Displacements were made in the horizontal and vertical direction at two flow velocities. For solution density and viscosity differences of 0.0034 g per ml and 0.003 centipoise, respectively, between the displacing and displaced solution, unstable flow was clearly demonstrated. In the simple glass bead porous system, unstable flow may be of greater significance than the concentration dependent nature of the diffusion coefficient. (auth)

5897 ION DIFFUSION. I. A QUICK-FREEZE METHOD FOR THE MEASUREMENT OF ION DIFFUSION IN SOIL AND CLAY SYSTEMS. D. A. Brown, B. E. Fulton, and R. E. Phillips (Univ. of Arkansas, Fayetteville). Soil Sci. Soc. Am., Proc., 28: 628-32(Sept.-Oct. 1964).

The method combines a radioisotope-tracer technique for measuring ion distribution by quick-freezing the exchange medium and sectioning it into 50μ segments with a refrigerated microtome. Ten-50μ sections were placed in separate counting pans for a quantitative radiation assay. From these data the distribution resulting from ion diffusion in montmorillonite and kaolinite clays and Sharkey and Dundee soils was obtained. The accuracy of the freezing and sectioning method was determined by using replicate-radioactive cores in which ion diffusion had not occurred. These cores were sectioned, counted for radiation, and then weighed. The coefficient of variation for the weight of clay or soil sections was 1.89, 2.14, 2.27, and 3.70% for kaolinite, montmorillonite, Dundee silt loam, and Sharkey clay, respectively. Coefficients of variation in the activity of the sections of exchange media were 2.39, 2.80, 3.18, and 1.29%, respectively. The coefficient of variation in the apparent diffusion coefficient for ^{86}Rb in replicated cores of kaolinite clay was 6%. (auth)

5898 INFRARED AND RAMAN VIBRATIONAL SPECTRA OF CHLORYL FLUORIDE (ClO_2F). D. F. Smith (Oak Ridge Gaseous Diffusion Plant, Tenn.). G. M. Begun, and W. H. Fletcher. Spectrochim. Acta, 20: 1763-70(Dec. 1964).

The infrared spectrum of gaseous chloryl fluoride was examined in detail from 300 to 4000 cm^{-1}. The chlorine and oxygen isotopic structures of many of the fundamental overtone and combination bands were resolved. The Raman spectrum of liquid chloryl fluoride was observed from 100 to 1500 cm^{-1} and polarization measurements recorded. All the fundamental frequencies of the molecule were observed in both the infrared and Raman spectra. Valence force constants were calculated, which closely reproduce the observed fundamental frequencies and their isotopic shifts. (auth)

5899 THE VIBRATIONAL SPECTRA OF n-PROPYL DERIVATIVES OF BORINE. I. THE INFRA-RED AND RAMAN SPECTRA OF TRI-n-PROPYL BORINE. M. G. H. Wallbridge (Univ. of Sheffield, Eng.). Spectrochim. Acta, 20: 1829-33(Dec. 1964).

The infrared and Raman spectra of isotopically normal tri-n-propyl borine were recorded over the ranges 4000 to 400 and 4000 to 200 cm^{-1} respectively. The infrared spectrum of the compound enriched in the ^{10}B isotope was also recorded. Various assignments of bands were made, and in particular the B–C asymmetric stretching frequency was corrected and re-assigned. (auth)

5900 PHOSPHORUS-31 NUCLEAR MAGNETIC RESONANCE STUDIES OF PHOSPHORUS-FLUORINE COMPOUNDS. John F. Nixon and Reinhard Schmutzler (University Chemical Lab., Cambridge, Eng.). Spectrochim. Acta, 20: 1835-42(Dec. 1964).

The ^{31}P nuclear magnetic resonance chemical shifts and phosphorus-fluorine coupling constants are reported for a wide variety of phosphorus fluorides, in which the coordination number of phosphorus can have the values three, four, five, and six. The chemical shifts extended over a wide range (~350 ppm) but were relatively constant for any particular class of compounds, and became more positive as the coordination number of phosphorus increased. The ^{31}P NMR spectra of the fluorophosphoranes, R_nPF_{5-n}, confirmed the previous conclusions regarding their stereochemistry. (auth)

5901 PREPARATION OF TRIMETHYLSILANOL-(D) $(CH_3)_3SiOD$. K. Licht and H. Kriegsmann (Deutsche Akademie der Wissenschaften, Berlin). Z. Anorg. Allgem. Chem., 325: 1-2(1963). (In German)

The preparation of trimethylsilanol-d is described. In a flask a solution of $(CH_3)_3SiF$ in diethyl ether was added to about 23% NaOD in D_2O, and the whole mixture was shaken vigorously for several minutes. Both solutions were cooled to about 0°C. The addition of ethereal $(CH_3)_3SiF$ to NaOD solution was successful only so long as the aqueous solution was still weakly alkaline, for the condensation of the silanol to hexamethyldisiloxane proceeds more rapidly in acid solution. The ether phase was then separated from the aqueous phase, dried over Na_2SO_4, and the ether removed by distillation. Finally the residue was distilled; after two distillations a product was obtained that boiled in the range 98–101°C. Because of the small amount of material it was not possible to distill through a column; the yield based on NaOD is about 20%. Among other causes, the low yield is probably due to the content of H_2F_2 in the ethereal $(CH_3)_3SiF$ solution, the boiling points being respectively 19.5 and 16.4°C. Analysis and infrared spectra indicated that the material was not free of $(CH_3)_3SiOH$. (BBB)

5902 DIFFERENTIATION OF RARE EARTH OXIDES ON CATALYTIC BASE USING PROMOTER IONS. Alfons Krause and J. Slawek (Universität, Poznan, Poland). Z. Anorg. Allgem. Chem., 331: 350-2(Sept. 1964). (In German)

The oxides La_2O_3, CeO_2, Nd_2O_3, and Pr_6O_{11}, which are strongly negative catalysts in H_2O_2 decomposition, behave as active carriers if doped with suitable active metal ions. (auth)

5903 HYPERFINE STRUCTURE OF DISSOLVED FREE RADICAL MOLECULES WITH SEVERAL EQUIVALENT NUCLEAR MOMENTS. W. Mueller-Warmuth (Max-Planck-Institut für Chemie, Mainz). Z. Naturforsch., 19a: 1309-17 (Nov. 1964). (In German)

Theoretical and experimental investigations of the hyperfine structure of free radicals in solution, for which an isotropic coupling of the unpaired electron spins existed for several equivalent nuclear moments, were made. The existing energy degeneration in strong magnetic fields was found to be to a great extent abolished in weaker fields, where additional splitting appeared. The characteristic energy values could be calculated if the operators of the individual equivalent nuclear spins were combined to a resulting nuclear spin, whereby various resulting quantum numbers appeared. Transitions were possible only between equally resulting nuclear spin quantum numbers. The re-

sults were interpreted with the help of a double resonance technique in weak magnetic fields for compounds. (tr-auth)

5904 DIFFUSION OF NON-GASEOUS FISSION PRODUCTS IN UO_2 SINGLE CRYSTALS. Noboru Oi and Jinzaburo Takagi (Tokyo Shibaura Electric Co., Ltd. and NAIG Nuclear Research Lab., Kawasaki, Japan). Z. Naturforsch., 19a: 1331-2(Nov. 1964).

An attempt was made to determine the diffusion constants of non-gaseous fission products, Ce, Ru, Zr–Nb, Sr, and Cs, in irradiated UO_2 single crystals, at temperatures from 1300 to 2500°C. Gamma spectra were measured before and after heating to determine released amounts of Ce, Ru, and Zr–Nb. For Sr and Cs, radiochemical separations were performed. No segregation was observed. Therefore, it was assumed that the diffusion of the fission products was caused mainly by their release from the surface of single crystals. Diffusion constants were plotted as a function of temperature. (M.C.G.)

5905 DETERMINATION OF ZIRCONIUM, ZIRCONIUM CARBIDE AND ZIRCONIUM DIOXIDE. L. S. Kozyreva, A. F. Kuteinikov, and N. P. Zharova. Zavodsk. Lab., 30: 1328-9(1964). (In Russian)

An analysis was made of Zr, ZrC, and ZrO_2 solubility in hydrofluoric, nitric, and sulfuric acids. (tr-auth)

5906 A STUDY OF THE SOLUBILITY OF LANTHANUM, CERIUM AND PRASEODYMIUM OXALATES BY A PHOTOMETRIC METHOD BY MEANS OF ARSENAZO III. V. F. Lukyanov and N. G. Moshchanskaya. Zh. Analit. Khim., 19: 264-5(1964). (In Russian)

The solubility of lanthanum, cerium, and praseodymium oxalates in water at 25°C was studied with high accuracy (the relative experimental error did not exceed 4.5%) by a photometric method using arsenazo III. A regular decrease of the solubility of oxalates in the series La–Ce–Pr was established. (auth)

5907 X-RAY INVESTIGATION OF LANTHANUM PHOSPHATES. V. G. Kuznetsov, V. P. Vasil'eva and I. V. Tananaev. Zh. Neorgan, Khim., 9: 2053-8(Sept. 1964). (In Russian)

An x-ray phase analysis was made of the lanthanum phosphates ($LaPO_4 \cdot 3H_2O$ and 9 $LaPO_4 \cdot La(OH)_3 \cdot 2.8H_2O$) in their initial state and following thermal treatments at 400, 500, and 1200°C. The thermograms indicate phase transformations which are in agreement with chemical analysis. (R.V.J.)

5908 THERMODYNAMIC CHARACTERISTICS OF URANIUM HALIDES UF_3Cl, UF_2Cl_2, AND $UFCl_3$. P. G. Maslov (Leningrad State Pedagogical Inst.). Zh. Neorgan. Khim., 9: 2076-8(Sept. 1964). (In Russian)

The heat capacity, enthalpy, and entropy of formation of UF_3Cl, UF_2Cl_2, and $UFCl_3$ crystals were studied at temperatures from 0 to 350°K with an order of accuracy of 0.4 to 0.8. The densities $\rho_{25°C}$ and melting points of the compounds were found. (R.V.J.)

5909 LANTHANUM PYROPHOSPHATES. I. V. Tananaev and V. P. Vasil'eva. Zh. Neorgan. Khim., 9: 2111-16 (Sept. 1964). (In Russian)

Solubility, pH, and specific electric conductivity of $La(NO_3)_3$–$Me_4P_2O_7$–H_2O at 25°C (Me = Li, Na, and K) indicated that reactions between La^{3+} and $P_2O_7^{4-}$ form the low-solubility complexes $La_4(P_2O_7)_3 \cdot 12H_2O$ and $MeLaP_2O_7 \cdot 4H_2O$ and a soluble complex ion $[La(P_2O_7)_2]^{5-}$. The saturation with $Me_4P_2O_7$ necessary for dissolving the precipitate is a function of the solubility index which goes as K > Na > Li. (R.V.J.)

5910 REACTIONS OF IMINODIACETIC ACID WITH ZIRCONIUM OXYCHLORIDES. L. N. Pankratova, A. V. Lapitskii, V. P. Vizgin, and L. G. Vlasov. Zh. Neorgan. Khim., 9: 2117-21(Sept. 1964). (In Russian)

Spectrophotometric analysis was made of reactions of zirconium oxychloride with iminodiacetic acid in pH 2 aqueous solutions. The molar absorption factor is 268. The instability of the $ZrOCl_2$ complex is $\approx 2 \times 10^{-12}$. (R.V.J.)

5911 SOLUBILITY OF ZIRCONYL OXALATE. L. M. Zaitsev and G. S. Bochkarev. Zh. Neorgan. Khim., 9: 2122-5(Sept. 1964). (In Russian)

Studies of the solubility of zirconyl oxalate in aqueous solutions at 25 ± 0.2°C indicated a solubility product of 0.98×10^{-10}. Approximate calculations were made of the zirconium ion in solutions with pH < 1. (R.V.J.)

5912 PREPARATION OF LANTHANUM BORIDE BY BORON CARBIDE REDUCTION OF LANTHANUM OXIDE. V. S. Neshpor. p.96-101 of "Vysokotemperaturnye Metallokeramicheskie Materialy." Kiev, Publishing House of the Academy of Sciences, 1962. (In Russian)

The preparation of LaB_6 and LaB_4 and attempts to prepare LaB_{12}, using reduction by B, C, and B carbides at various temperatures, are described. Results of chemical analysis and phase x-ray analysis of the reaction products are presented. (M.J.T.)

5913 THE THERMOELECTRIC POWER OF GRAPHITE AS AFFECTED BY OXYGEN CHEMISORPTION. James Joseph Tietjen. Thesis, University Park, Penna., Pennsylvania State Univ., 1963. 52p.

A thermoelectric power generator was designed and constructed for measuring the thermoelectric power (α) of compacted natural graphite crystals. Measurements were made on both high purity samples (I) and those containing trace amounts of iron (II). The thermoelectric power of the graphite systems (I and II) was found to be negative, to be a linear function of the absolute temperature over the temperature range 300° to 725°K, and to be of the order of 1 μV/°K. A detailed investigation of the effect on α of variations in molding pressure and the rate of application of the molding pressure revealed that a negligible effect on the value of α was produced by varying these parameters about the sample preparation values. It is concluded that with the sample preparation conditions employed a high degree of crystallite alignment was achieved. Because of this high degree of crystallite alignment, the systems involved in this study are assumed to be best described mathematically as having a thermal gradient impressed along the a crystallographic direction of graphite. It was observed that chemisorption of oxygen on these graphite specimens raises the value of α while maintaining the linear temperature dependence. This effect is best explained by assuming that electrons are removed from the conduction system in the formation of a carbon-oxygen surface complex. The effect of chemisorbed oxygen on the thermoelectric power of graphite was used in conjunction with mass spectrometric determinations of the extent of complex formation to determine the rate of oxygen chemisorption on the graphite systems I and II at atmospheric pressure. The results agree with an assumption that the reaction is first order with respect to both reactants and the rate constant is independent of the extent of surface coverage. Iron was found to have a slight catalytic effect on the reaction. (A.G.W.)

5914 EQUILIBRIA IN THE ION EXCHANGE SYSTEMS H^{+1}–Cs^{+1}, H^{+1}–Sr^{+2}, H^{+1}–Ce^{+3}, Cs^{+1}–Sr^{+2}, Sr^{+2}–Ce^{+3}, H^{+1}–Cs^{+1}–Sr^{+2}, H^{+1}–Cs^{+1}–Ce^{+3} AND H^{+1}–Sr^{+2}–Ce^{+3}. Walter Meyer. Thesis, Corvallis, Ore., Oregon State Univ., 1964. 204p.

A new method for determining ion exchange equilibrium data by liquid scintillation counting of the equilibrated solution phase is described. This method was applied to determine equilibria between Dowex 50W X8, a commercial strong cation exchange resin, and binary and ternary solution containing varying combinations of H^{+1}, Cs^{+1}, Sr^{+2} and Ce^{+3}. Equilibrium isotherms at room temperature are presented for total solution normalities of 0.1, 0.5 and 1.5, 2.5 or 3.0. These data are correlated and examined in terms of phase, chemical, and Donnan equilibrium theories. Finally the feasibility of determining ternary equilibrium data from binary data is examined. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

5915 THE SPECTRUM OF NITROUS OXIDE AND ITS ISOTOPES IN THE 8 MICRON REGION. Ronald

Patrick Grosso. Thesis, University Park, Penna., Pennsylvania State Univ., 1963. 95p.

Measurements were made of the vibrational-rotational bands of $N_2^{14}O^{16}$, $N^{15}N^{14}O^{16}$, and $N_2^{15}O^{16}$ occurring in the infrared region of the spectrum near 8 microns. This work was performed using a recently developed grating-prism spectrometer capable of resolving 0.08 cm^{-1}. The measured spectrum was used to calculate values of the band origins and the rotational constants of the (100-000), (02^00-000), (11^10-01^10), and (03^10-01^10) bands. A value of q_{03^10} was calculated for each molecule using the resolved l-doublets. A value of k_{122}, a coefficient in the cubic potential was calculated for each molecule using the equations resulting from the Fermi resonance between the (100) and (02^00) states and between the (11^10) and (03^10) states. The observed value of ΔD_{03^10} for $^{14}N_2$ ^{18}O was found to be in excellent agreement with the value calculated using the theory of L-type resonance. Some of the data of the isotopes could not be described adequately using the usual isotopic relation. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

5916 MAGNETIC SUSCEPTIBILITY OF PRASEODYMIUM OXIDES. Sanford Kern. Thesis, Lafayette, Ind., Purdue Univ., 1963. 154p.

A magnetic susceptibility study was made of the praseodymium oxides Pr_2O_3, $PrO_{1.72}$, $PrO_{1.83}$, and PrO_2. A vibrating-sample magnetometer was constructed to perform the measurements, which extended over the region from liquid helium to room temperature. All of the materials obeyed the Curie-Weiss law at the higher temperatures; however, in the very low temperature region, the susceptibilities for the various praseodymium oxides no longer conformed to the Curie-Weiss law. A theoretical interpretation using crystal field theory, for the two end members, Pr_2O_3 and PrO_2, was attempted on the basis of their reported structures, but was unsuccessful. The analyses indicated that neither exists in the crystal structure previously cited for it; instead, both exhibit D_{3d} symmetry for the disposition of the oxygen ions about the central cation. For PrO_2 the temperature variation of the magnetic susceptibility was best explained on the assumption that two oxygen ions along one of the (111) axes of the eight-coordinated cube were distorted from their original positions. The cubic Pr_2O_3 lattice may be thought of as derived from PrO_2 by the removal of two of the eight oxygens surrounding the cation. For this structure the symmetry is, again, D_{3d}. The crystal field potential based on this arrangement of ions gave good agreement with the susceptibility results, even though only fourth order terms were initially included in the potential. Included are tables of the computed matrix elements, with graphs illustrating the crystal field splittings and the effect on the energy levels of mixing the different order terms in the potential. Applying the computed results to the intermediate compositions $PrO_{1.72}$ and $PrO_{1.83}$ gave fair agreement with the experimental work. Measurements performed on the hexagonal modification of Pr_2O_3 are also reported. (A.G.W.)

5917 KINETIC ISOTOPE EFFECTS IN THE SOLVOLYSIS REACTIONS OF BORON HYDRIDES. Charles Leonard Kibby. Thesis, Lafayette, Ind., Purdue Univ., 1964. 310p.

The rates of solvolysis of sodium borohydride and sodium borodeuteride in methanol and in aqueous buffers were studied as a function of temperature in a quest for proton tunnelling. General acid catalysis is observed in these reactions, and hydrolysis rates are greater in light water than in heavy water; therefore the rate-determining step involves a slow proton transfer. Hydrogen gas and aquated borane are formed in the rate-determining step for sodium borohydride hydrolysis, so there is a simultaneous hydride transfer. The hydrogen-deuterium kinetic isotope effect in the hydride transfer, k_H/k_D, is 0.70 at 25°C for both hydrolysis and methanolysis. This inverse isotope effect is attributed to a large secondary isotope effect of the three hydrogen or deuterium atoms not undergoing protonolysis. Large changes in force constants for stretching frequencies, in forming the transition state, are believed responsible. It was found that the variation in k_H/k_D from −98° to 35°C is accurately predicted by a simple Arrhenius relationship. The kinetic isotope effect in the hydrolysis of pyridine phenylborane and pyridine phenylborane-d_2 at 25°C was investigated. An inverse kinetic isotope effect, $k_H/k_D \approx 0.9$, was found for this reaction, although there is only one secondary hydrogen or deuterium atom on the boron. A study of the kinetic isotope effects in the hydrolysis of trimethylamine borane and trimethylamine borane-d_3 revealed that trimethylamine borane rapidly exchanges hydrogen with hydronium ion. The exchange reaction is more than one hundred times faster than the hydrolysis; therefore it is possible to prepare trimethylamine borane-d_3 in high yield from the reaction of trimethylamine borane in acidic heavy water solutions. Inexpensive reductive deuterations of ketones to α-deuterioalcohols and deuterioborations of olefins may be accomplished using this exchange reaction, since heavy water is the source of the deuterium. (Dissertation Abstr., 25: No. 2(Aug. 1964))

5918 THE POLAROGRAPHIC BEHAVIOR OF AQUEOUS SOLUTIONS OF DYSPROSIUM(III). Robert Franklin Large. Thesis, East Lansing, Mich., Michigan State Univ., 1963. 86p.

An investigation of the polarographic behavior of the tripositive lanthanide ions having no stable dipositive state in aqueous solution was conducted employing the dysprosium (III) ion as a representative of the group. Two waves related to the lanthanide ion were observed, the characteristics of which were quite dependent on the pH of the solution. The first wave was shown to involve the reduction of hydrogen ion and to be partially kinetic controlled. The current resulting from the second process associated with the lanthanide ion does not vary linearly with the concentration of dysprosium(III), and is dependent on the pH, the current decreasing as the pH decreases. The i-t curves obtained at potentials during the development of both waves show reproducible irregularities of an unprecedented nature, and denote unusual phenomena occurring at the electrode surface. Electrocapillary curves obtained in the presence of dysprosium(III) also show an irregularity in the potential region of the second wave. The choice of supporting electrolyte was shown not to be of significance. A comparison of i-E curves obtained for lanthanum(III), gadolinium(III), and lutetium(III) with those of dysprosium(III) shows a similar behavior for all these ions with a shift in the waves to more negative potentials with increasing basicity of the ion. It was concluded that the polarographic waves observed for aqueous solutions of dysprosium(III) are the result of the reduction of hydrogen ions produced by the hydrolysis of the lanthanide ion in the immediate vicinity of the electrode followed by the adsorption of the lanthanide hydrous oxide produced in the hydrolysis, which results in reduction of additional hydrogen ions from water associated with the lanthanide hydrous oxide. (A.G.W.)

5919 A TWIN-CRUCIBLE STUDY OF THE LITHIUM FLUORIDE–BERYLLIUM FLUORIDE SYSTEM. Alfred Buechler and James L. Stauffer (Arthur D. Little, Inc., Cambridge, Mass.). 6p. (CONF-649-9)

From 12th Annual Conference on Mass Spectrometry and Applied Topics, Montreal, June 1964.

The design of a twin-crucible source that permits the direct comparison, in a single experiment, of the mass spectra of vapors, such as a pure compound and a mixture, is described. Using the crucible design it was possible to obtain information concerning the activities of LiF and BeF_2 in the solutions examined and the fragmentation patterns of the mixed Li–Be species $LiBeF_3$ and Li_2BeF_4. The results are discussed. (P.C.H.)

5920 THE ADSORPTION OF VARIOUS RADIOISOTOPES UPON SELECTED MATERIALS. G. B. Morgan, E. H. Galbraith, and F. W. Gilcreas. 12p. (CONF-555-9)

From International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964.

The adsorption of radioisotopes upon commonly encoun-

tered construction materials was investigated. Solutions containing microquantities of the radioisotopes in question were made up at pH 6.0 with the ionic strength approximately 4.0×10^{-3}. Construction materials such as lime glass, pyrex, paraffin, mylar, polypropylene, polyethylene, butadiene rubber, and neoprene rubber were used. It was found that the adsorption on glass is primarily a function of alkali oxides present in the glass since these ions are principal charge carriers. High silica glasses adsorbed much less than lime glass. It was also observed that as the pH decreased adsorption also decreased, however some elements that undergo primarily chemisorption did not remain completely in solution even at a negative pH value. Of the radionuclides investigated ^{65}Zn was found to be adsorbed to the greatest extent. Polyethylene and polypropylene proved to adsorb less radioisotopes than the other materials tested. The idea of coating the inside of glass or metal with rubber or paraffin was definitely contraindicated. Neoprene rubber because of its configuration adsorbed to the extent that it should be classified as an ion exchange resin. For nonvolatile elements the best method found for collecting samples for radioanalyses is so that the concentration in the final sample is 0.1 N HNO_3 in either polyethylene or polypropylene containers. Neither ^{226}Ra or ^{90}Sr the two most biologically significant radioisotopes were adsorbed to any appreciable extent by these materials at this pH. (auth)

5921 EXPERIMENTAL STUDY OF THE MAGNETIC FIELD DEPENDENCE OF SPIN-LATTICE RELAXATION BY THE ORBACH PROCESS IN NEODYMIUM MAGNESIUM NITRATE. J. T. Hoffman and R. C. Sapp (Univ. of Kansas, Lawrence). 30p. (CONF-417-33)

From American Physical Society Meeting, Pasadena, Calif., Dec. 1963.

The spin-lattice relaxation time of trivalent Nd ions in Nd–Mg nitrate was measured by fitting Casimir-du Pré dispersion curves to the frequency dependence of the self-inductance of a coil into which the sample could be inserted. The difference in self-inductance, with and without the sample, was determined by a modified Owen bridge at liquid helium temperatures and in fields between zero and 1800 Oe. In the 3.3–4.2°K range the Orbach process dominates and is identified by its characteristic exponential inverse temperature variation. For H perpendicular to the crystal axis, good agreement is found with Orbach's theory for the magnetic field dependence of this process, $T_1^{-1} = A \exp(-\Delta/kT)(H^2 + 10^5\mu + 3600\mu')/(H^2 + 10.4 \times 10^4)$ sec^{-1}, with the following values for the parameters: $A = (13 \pm 1) \times 10^8$ sec^{-1}, $\Delta/k = 48.2 \pm 0.1$°K, $\mu \leq 2.5 \pm 0.1$; μ' could not be estimated. As by-products of the experiments the magnetic specific heat constant $b = T^2C_{H=0} = (8.1 \pm 0.2) \times 10^4$ erg-deg/gm ion, and the temperature-independent susceptibility $\alpha_\perp = 0.021 \pm 0.002$ gm ion^{-1} were also obtained. (auth)

5922 PROCESS FOR THE PRODUCTION OF ZIRCONIUM COMPOUNDS, MORE ESPECIALLY BASIC ZIRCONIUM SULPHATE. (to Deutsche Gold-und Silber-Scheideanstalt). British Patent 971,594. Sept. 30, 1964. Priority date Sept. 3, 1960, Germany.

In the process described the suspension of an alkali metal zirconium silicate is first treated with that quantity of an acid necessary completely to convert the alkali metal portion into the corresponding salt. This addition takes place so slowly that the temperature does not rise about 100°C. The residual quantity of acid necessary completely to convert the zirconium into a salt of the acid is then supplied quickly and the precipitated silica is separated out. A basic zirconium sulfate is prepared from the filtrate by adding SO_4^{2+} ions. A coarse-grain basic zirconium sulfate is formed by heating the solution slowly at 40 to 50°C. A fine-grain product is formed by heating as quickly as possible to 100°C. (A.G.W.)

5923 IMPROVEMENTS IN AND RELATING TO THE MANUFACTURE OF OXIDES. James Thomson Richmond (to Laporte Titanium Ltd.). British Patent 971,747. Oct. 7, 1964. Filed Feb. 23, 1960.

A process is described for manufacturing an oxide of one of the elements Ti, Zr, Al, or Si by reacting a chloride of the element with an oxidizing gas in the vapor phase. The reaction is carried out within a bed of particles of an oxide of one of the elements, or a mixture of them, maintained in a fluidized condition at a temperature within the range of 750 to 1500°C. A part of the oxide produced is entrained in the gas stream leaving the bed and part is deposited on the particles of the bed causing them to grow in size. Size distribution of the oxide particles is controlled by withdrawing particles from the oxidation zone, reacting the withdrawn particles with a chlorinating and reducing agent to form oxide particles of reduced size and the vapor of the chloride. The oxide particles of reduced size and the chloride vapor are then returned to the oxidation zone. Ultimately substantially all the chloride is converted into a finely divided form of oxide carried out of the bed in the gas stream. Preferably the oxidation and chlorination zones are different zones of the same reactor. A suitable apparatus is described. (A.G.W.)

5924 PURIFICATION OF CARBON DIOXIDE. (to Gesellschaft fur Linde's Eismaschinen AG). British Patent 972,044. Oct. 7, 1964. Priority date July 4, 1962, Germany.

Processes and apparatus are described for reducing the content of lower-boiling trace impurities in carbon dioxide. The compressed incoming carbon dioxide is subjected to a rectification process to produce a substantially pure liquid carbon dioxide fraction and a gaseous carbon dioxide fraction in which impurities are concentrated. The incoming carbon dioxide serves as a source of refrigeration for the rectification step and the separated gaseous carbon dioxide fraction in which impurities are concentrated serves as a source of reflux liquid for the rectification step. The process is particularly applied to the purification of reactor cooling gas. (A.G.W.)

5925 IMPROVEMENTS IN OR RELATING TO THE PREPARATION OF URANIUM DIOXIDE. Rokuo Ukaji and Hiroyuki Wada (to Osaka Kinzoku Kogyo Co. Ltd.). British Patent 972,152. Oct. 7, 1964. Filed Feb. 22, 1962.

The method described for preparing uranium dioxide consists of forming in a reaction zone a vertical vortex of an admixture of gaseous UF_6, a gaseous reducing agent, and excess steam and maintaining the mixture at a temperature in the range of 350 to 550°C. The desired solid uranium dioxide is substantially separated at the bottom of the reaction zone, and any gaseous products of the reaction are withdrawn at the top. Suitable reducing agents include hydrogen, ammonia, or carbon monoxide or a mixture of two or more of these. Preferably 2 to 15 parts by weight of steam are used for each part by weight of reducing agent. An apparatus suitable for carrying out the method is described. Uranium dioxide is obtained in the form of a fine homogeneous powder with a fluoride content of less than 0.01% by weight. (A.G.W.)

5926 DISSOLUTION OF URANIUM OXIDE. Maurice C. Lambert (to U. S. Atomic Energy Commission). U. S. Patent 3,160,470. Dec. 8, 1964.

A process was developed for expediting dissolution of UO_2 or U_3O_8 in molten NaCl–KCl, $PbCl_2$–KCl, $MgCl_2$–KCl, LiCl–KCl, $ZnCl_2$–KCl, $CaCl_2$–NaCl, or LiCl–NaCl in the presence of chlorine gas or phosgene by the addition of catalytic amounts of thallous chloride or ferrous chloride. (AEC)

5927 PREPARATION OF DENSE URANIUM DIOXIDE PARTICLES. Irving E. Knudsen, Albert A. Jonke, and Norman M. Levitz (to U. S. Atomic Energy Commission). U. S. Patent 3,160,471. Dec. 8, 1964.

A method was developed for converting uranium hexafluoride to high-density uranium dioxide. A fluidized bed of uranium dioxide particles is established and maintained by passing between 0.75 and 1.40 times the stoichiometric requirement of steam and at least 5 times the stoichiometric requirement of hydrogen upwardly through it, heating the bed to a temperature of at least 650°C, and feeding uranium hexafluoride to the bottom of the bed intermittently. (AEC)

5928 ELEMENT 96 AND COMPOSITIONS THEREOF. Glenn T. Seaborg (to U. S. Atomic Energy Commission). U. S. Patent 3,161,462. Dec. 15, 1964.

The element having atomic number 96, known as curium, to certain compounds of curium, and methods for producing curium and for separating curium from solutions thereof are discussed. (AEC)

5929 PROCESS FOR PREPARATION OF SULFUR-CONTAINING COMPOUNDS OF PLUTONIUM. Norman R. Davidson (to U. S. Atomic Energy Commission). U. S. Patent 3,162,509. Dec. 22, 1964.

A process was developed for preparing a plutonium sulfide by reaction of plutonium dioxide with hydrogen sulfide in the presence of graphite at elevated temperature. (AEC)

5930 PLUTONIUM ALLOYS CONTAINING CONTROLLED AMOUNTS OF PLUTONIUM ALLOTROPES OBTAINED BY APPLICATION OF HIGH PRESSURES. Reed O. Elliott and Karl A. Gschneidner, Jr. (to U. S. Atomic Energy Commission). U. S. Patent 3,162,527. Dec. 22, 1964.

A method was developed for making stabilized binary alloys of plutonium with the binary element selected from aluminum, zinc, or gallium. The alloy is compressed to at least a pressure marked by rapid increase in density of the alloy with a negligible increase in pressure, and wherein the resulting volume decrease of the alloy with increasing pressure is negligible. (AEC)

Organic Chemistry

Refer also to abstract 5720.

5931 (TID-21368) ISOTOPE EFFECTS AND TRACER STUDIES INVOLVING ALLYL-1-C^{14} CARBANION. Final Report. E. Grovenstein, Jr. (Georgia Inst. of Tech., Atlanta). Aug. 31, 1964. Contract AT(40-1)-2453. 6p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The ^{14}C distribution of allyl chloride, allyltrimethylammonium chloride, and p-tolyl allyl sulfide synthesized from allyl-1-^{14}C alcohol are described. These compounds were cleaved by Na or Li metal in liquid NH_3 containing excess NH_4Cl or CH_3OH to give propylene with ^{14}C distributed almost equally at C-1 and C-3, and it is concluded that the allyl group cleaves as the anion, while the cyclopropyl group cleaves as a free radical. The omission of NH_4Cl or CH_3OH from the cleavage solution results in the formation of propylene with more ^{14}C at C-1 than at C-3, and of biallyl and its isomers. Studies of biallyl formation from allyl-1-^{14}C chloride indicate that the mechanism is S_N2 displacement of allyl anion upon allyl chloride. (D.L.C.)

5932 (TID-21381) TRACER STUDIES IN CLEAVAGE OF ALLYL-1-C^{14}-TRIMETHYLAMMONIUM CHLORIDE, ALLYL CHLORIDE-1-C^{14}, ALLYL ALCOHOL-1-C^{14} AND p-TOLYL ALLYL-1-C^{14} SULFIDE WITH METALS (thesis). Suresh Chandra (Georgia Inst. of Tech., Atlanta). Mar. 1961. Contract AT(40-1)-2453. 155p. Dep.(mn); $5.00 (cy), 3(mn) OTS.

Allyltrimethylammonium chloride, allyl chloride, allyl alcohol, and p-tolyl allyl sulfide (all labeled in the allyl group with carbon-14 predominatingly at carbon-1) have been synthesized starting with radioactive sodium cyanide. Reductive cleavages of radioactive and non-radioactive allyl compounds have been studied most extensively with sodium and lithium. Zinc dust in acetic acid was also used to cleave allyl chloride and allytrimethylammonium chloride. Most of the reactions with alkali metals were carried out in liquid ammonia with or without the addition of ammonium chloride. The effect of addition of ammonium sulfate and of methanol was also studied in the reaction of allyltrimethylammonium chloride with sodium in liquid ammonia. Once 2-propanol was used as a solvent in reaction of allyltrimethylammonium chloride with sodium. The gases evolved in the reactions were analyzed for propylene and methane by an infrared absorption technique. In a few reactions (only of non-radioactive allyltrimethylammonium chloride and allyl chloride) the products were analyzed for olefins by gas chromatography. Allyl chloride was found to react with sodium in liquid ammonia without ammonium chloride to give biallyl as major olefin with propylene and a few percent of products which, on the basis largely of their retention times, are judged to be isomers of biallyl. Addition of ammonium chloride to the liquid ammonia solution greatly increased the yield of propylene relative to biallyl and gave no detectable amount of isomers of biallyl. Biallyl and its isomers were also produced in cleavage of allyltrimethylammonium chloride though in poorer yields than in cleavage of allyl chloride. These results suggest that biallyl is produced by reaction of allyl carbanion with allyl compounds by mechanism S_N2 and that ammonium chloride greatly reduces the amount of biallyl by rapid protonation of allyl carbanion to give propylene. However, these results do not rule out the possibility of concurrent or prior formation of allyl radical as an intermediate, and there is some possibility that part of the biallyl is formed through dimerization of allyl radicals since ammonium chloride did not entirely eliminate the formation of biallyl. Ozonization of the propylene, formed from cleavages of allyl-1-C^{14} compounds, gave formaldehyde with 3.3 to 13.5 percent greater radioactivity than in the concomitant acetaldehyde. These results are strikingly independent of the structure of the organic compound, the nature of the metal, the nature of the solvent, or the reaction temperature (−72° to 50°). The addition of ammonium chloride lowers the radioactivity in formaldehyde by 2.0 to 9.8 per cent. A similar effect is observed on addition of methanol or upon using 2-propanol as solvent. It is likely that allyl-1-C^{14}-trimethylammonium chloride and p-tolyl allyl-1-C^{14} sulfide are rearranged to the corresponding propenyl-1-C^{14} compounds to some extent by bases such as allyl carbanion or amide ion and that the rearranged reactants upon reductive cleavage give propylene-1-C^{14} (but no propylene-3-C^{14}). No such rearrangement of the reactants seems likely in presence of ammonium chloride or other acid. A tentative conclusion of this study is that a kinetically free allyl carbanion is produced as an intermediate during reductive cleavage of allyl compounds and that protonation of this carbanion gives propylene. In runs in which ammonium chloride, methanol, 2-propanol, and acetic acid were present, the ratio of activity of formaldehyde methane derivative to that of acetaldehyde methane derivative (obtained from ozonization of propylene) was 1.056 ± 0.016. The most likely explanation for this ratio is that an isotope effect (k_{12}/k_{14}) of this order of magnitude exists in the protonation of allyl carbanion. (auth)

5933 (TID-21391) REACTIONS OF ALLYL CHLORIDE, ALLYLTRIMETHYLAMMONIUM CHLORIDE, AND CYCLOPROPYLTRIMETHYLAMMONIUM IODIDE WITH SODIUM IN LIQUID AMMONIA (thesis). Charles Edward Collum (Georgia Inst. of Tech., Atlanta). Sept. 1964. Contract AT(40-1)-2453. 97p. Dep.(mn); $3.00(cy), 2(mn) OTS.

This work was carried out with three purposes: (1) to study the cleavage of quaternary ammonium salts by sodium in liquid ammonia and determine qualitatively and quantitatively the products of cleavage; (2) to see if allyltrimethylammonium chloride can be isomerized by a strong base such as potassium amide in liquid ammonia; and (3) to determine by the use of radioactive allyl-1-C^{14} chloride the mechanism for the reaction of allyl chloride with sodium in liquid ammonia to form biallyl. The cleavage of 3-chloropropyltrimethylammonium chloride resulted in the formation of propane, propylene, cyclopropane, and methane with the yield of each hydrocarbon varying from run to run and the total yield of hydrocarbons varying from 12 to 82 per cent. This cleavage is believed to be complicated because of the heterogeneous nature of part of the reaction. Cyclopropyltrimethylammonium iodide was cleaved with sodium in liquid ammonia to give mostly cyclopropane and methane. It was found that the ratio of cyclopropane to methane varied with the quantities of reactants used and with the mode of addition of reactants. This variation is

thought to result from cleavage of the cyclopropyl group as a free radical and cleavage of methyl as a carbanion; with increasing concentration of sodium, cleavage of methyl as a carbanion becomes more favored. The allyltrimethylammonium chloride was cleaved a total of eight times with the sodium to salt ratio varying from 2.2 to 60. The order of addition of reactants was also varied. It was found that the ratio of higher molecular weight hydrocarbons to methane remained constant over all reactions with a value of 2030 ± 320. This constancy is a good indication that both allyl and methyl are cleaved as carbanions since the ratio does not change over the wide range of concentrations studied. The isomerization of allyl-1-C^{14}-trimethylammonium chloride was carried out using potassium amide in liquid ammonia. The amide was formed by adding potassium to liquid ammonia and letting the mixture stand in the absence of a catalyst. The isomerized compound was cleaved with sodium after destroying the potassium amide with ammonium chloride. Radiochemical assay of the propylene produced indicated that some isomerization occurred under the conditions investigated. When allyl chloride is reacted with sodium in liquid ammonia, biallyl and isomers of biallyl are produced along with propylene. The main purpose of this research was to try to determine the mechanism of the reaction of allyl chloride with sodium to form biallyl by the use of carbon-14 as a tracer. Three different mechanisms are considered along with molar activities expected for each mechanism. Two runs were made using allyl-1-C^{14} chloride. The analyses of the first run were not all reliable so a second run was made. The results of the first run gave a good indication that the mechanism consists of an S_N2 displacement of allyl carbanion upon allyl chloride. The second run indicated that there could be a simultaneous S_N2' displacement of allyl carbanion upon allyl chloride or alternately some formation of biallyl by coupling of allyl free radicals. The results, however, could also be explained by ionization of allyl chloride in liquid ammonia or by the biallyl undergoing a Cope rearrangement in the v.p.c. during separation. The final conclusion is that most or possibly all of the biallyl is formed by S_N2 displacement of allyl carbanion upon allyl chloride. (auth)

5934 (UCRL-11649) TEMPERATURE DEPENDENCE OF FLUORINE MAGNETIC RESONANCE SPECTRA (thesis). Richard Newmark (California. Univ., Berkeley. Lawrence Radiation Lab.). Nov. 1964. Contract W-7405-eng-48. 194p. Dep.(mn); $5.00(cy), 3(mn) OTS.

The theory of Kaplan for exchange in nuclear magnetic resonance (NMR) systems has been modified for exchange between three species with any number of nuclei of spin ½, in which all the nuclei in each species are exchanged by the interconversion. A set of explicit equations for the density matrix elements in this case is written down. Computer programs have been written to solve the equations in the two and three spin cases. The results enable the calculation of NMR spectra of highly coupled nuclei undergoing exchange. Absolute reaction rate theory has been used to express the rates of exchange in terms of activation energies. This has been combined with the Kaplan theory to determine the free energies of activation for the internal rotation of several halogenated ethanes, $CFCl_2-CFCl_2$, $CF_2Br-CCl_2Br$, $CF_2Br-CFBr_2$, $CF_2Br-CFBrCl$, $CFClBr-CFClBr$, and $CF_2Br-CHBrCl$. Spectra were calculated assuming the limiting values for the transmission coefficient, $K \ll 1$, $K = 1$. In the first case free rotation occurs when the rotamer has sufficient energy to exceed the barriers. Alternatively, the second case implies that deactivation occurs almost immediately after rotation occurs. The experimental results on $CF_2Br-CCl_2Br$ can only be explained by the second possibility. The barriers are discussed in terms of the distortion necessary to form the activated complex in which the substituents are eclipsed. The low temperature spectrum of the three rotamers of $CF_2Br-CHBrCl$ shows two larger vicinal HF coupling constants (18 cps) and four small ones (less than 3 cps). The assignment of the rotamers made assuming that the low barrier observed between two of the rotamers does not involve eclipsing two large halogens indicates that the large coupling constants are trans and the four others are gauche coupling constants. (auth)

5935 A MODIFIED SYNTHESIS OF METHYL-d_3 BROMIDE. M. Nikoletic-Valentekovic (Institut "Ruder Boskovic," Zagreb). Croat. Chem. Acta, 36: 43-4(1964).

The preparation of methyl-d_3 bromide is a four-step process: reaction carbon suboxide with deuterium oxide to give malonic-d_2 acid-d_2; decarboxylation to acetic-d_3 acid-d; preparation of the silver salt; and conversion of silver acetate-d_3 to methyl-d_3 bromide by a modification of the Hunsdiecker reaction. When the reaction was carried out on a 0.25 mole scale the yield was 60% based on deuterium oxide. (M.C.G.)

5936 INFRARED SPECTRA OF ADENOSINE TRIPHOSPHATE COMPLEXES IN DEUTERIUM OXIDE SOLUTION. Kikry L. Khalil and Theodore L. Brown (Univ. of Illinois, Urbana). J. Am. Chem. Soc., 86: 5113-17(Dec. 5, 1964).

Infrared spectra were obtained for 0.1M Na_2H_2ATP in D_2O, alone and in the presence of 0.1M divalent metal ions. Acid dissociation constants for H_2ATP^{2-}, which were in good agreement with those determined by titrimetric methods, were calculated from the pD dependence of the spectrum. The effect of metal ions was seen in the shift in pD values at which ionizations of protons occurred. On the basis of the shifts in pD values, the apparent formation constants of divalent metal ions with ATP were in the order $Cu^{2+} > Zn^{2+} > Ni^{2+} > Mg^{2+} > Ca^{2+}$. The formation constants for 1:1 complex formation with Mg^{2+} and Ca^{2+} were calculated from the infrared data. Agreement with "best estimates" of these quantities based on published results was obtained only when the increased acidity of the proton bound to the adenine moiety was considered. This result was not interpreted to mean that metal binding necessarily occurs at the adenine moiety. It was proposed rather that complex formation occurs at the triphosphate group in advance of proton loss from the terminal phosphate. This view of the equilibria was in accord with other published evidence. Neither infrared nor pH titrimetric methods could provide a reliable measure of the formation constants for binding of metal ions under these circumstances, since there was not a necessary correspondence between proton displacement and metal binding. (auth)

5937 PREPARATION OF IODINE-131-LABELLED ROSE-BENGAL BY RADIOACTIVE EXCHANGE METHOD. Teng-yueh Chen and Si-jung Yeh (National Tsing Hau Univ., China). J. Chinese Chem. Soc. (Taiwan), 11: 94-101(June 1964).

Labeling of rose bengal with ^{131}I was studied by using carrier-free $Na^{131}I$. The effects of pH and hydrogen peroxide on the radioactive exchange reaction were investigated. It was observed that as high as 88% of ^{131}I was exchanged under optimum conditions found in the present study. The purity of the labeled rose bengal obtained by the exchange method was examined by paper chromatography, and found to be satisfactory. (auth)

5938 ISOTOPE EFFECTS IN THE INFRA-RED SPECTRA OF SOME CARBON-14-LABELLED ACIDS, AN ESTER AND SODIUM SALT. B. H. Baxter and A. F. C. Horsler (Radiochemical Centre, Amersham, Bucks, Eng.). Nature, 204: 675-6(Nov. 14, 1964).

The spectra of some carbon-14 acids, an ester, and sodium salts labeled at high specific activity in the 1-position are reported. The spectrum of methyl stearate shows an additional peak at 1,661 cm^{-1} corresponding to $^{14}C = 0$ stretching, and at a frequency close to that calculated. Similarly in the spectrum of sodium formate each of the peaks from 1,667 to 741 cm^{-1} is also split. However, the free acids exhibit, instead of the expected effects, a complex band system, the origin of which is as yet unexplained. Attention is directed to possible errors due to isotope shifts that might arise in purity determination of ^{14}C-labeled compounds by infrared spectrometry. (P.C.H.)

5939 THE KINETIC ISOTOPE EFFECT IN ELIMINATIONS AND SOLVOLYTIC REACTIONS OF CYCLO-

HEXYL p-TOLUENESULFONATES. Kay Thomas Finley. Thesis, Rochester, N. Y., Univ. of Rochester, 1963. 82p.

Since elimination reactions involving the formation of a double bond in a cyclic system appear to differ in some more or less fundamental way from the bulk of the vast literature on such reactions, it was proposed to investigate the intimate details of these reactions. In order to accomplish this goal most effectively, it was decided to study the kinetic isotope effect. A series of stereospecifically deuterated cyclohexyl p-toluenesulfonates were prepared, and their rates of E2 reaction were studied with alkoxides in the corresponding alcohol as solvent. The solvolysis reaction with anhydrous acetic acid was also carried out. In every case, the rate of the deuterated compound was lower than the undeuterated compound under the same conditions. Therefore, there are presented examples of primary, alpha and beta secondary, and a combined primary and beta secondary deuterium isotope effect. Each of these was compared with earlier data and interpreted in the light of present knowledge. The relationship of the isotope effects to changes in solvent and base was discussed and the evidence obtained was applied to the possible configuration of the transition state in E2 and E1-S_N1 reactions. The apparent contradictions of certain pieces of evidence were pointed out and attempts made to provide a reasonable explanation of them. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

Radiation Chemistry

5940 (AERE-R-4725) RADIATION DAMAGE IN POLYPROPYLENE. R. L. Vale (United Kingdom Atomic Energy Authority. Research Group. Wantage Research Lab., Wantage, Berks, England). Oct. 1964. 20p. Dep.; $0.60(BIS), 3s.(HMSO).

The effects of gamma and high energy electron radiation on the molecular weight and mechanical properties of a range of commercial polypropylene resins are described. The predominant reaction is chain scission, accelerated by the presence of oxygen. The dose rate dependence of the reaction is shown to be mainly due to the rate controlling diffusion of oxygen into a sample during irradiation, and similarly post irradiation damage is also due to oxidation. This information is applicable to other systems showing oxidative radiation damage. (auth)

5941 (NAA-SR-9731) RADIOLYSIS PRODUCTS OF POLYPHENYL COOLANTS. PART III. OMRE HIGH BOILERS. R. T. Keen, W. L. Orr, L. J. Miller, R. J. Sullivan, and R. C. Shepard (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 15, 1964. Contract AT(11-1)-Gen-8. 94p. Dep.; $3.00 (OTS).

The nature of the high boiling radiolysis products of OMRE coolants was studied extensively. The high boilers are a complex mixture of polyphenyls, with smaller amounts of triphenylenes, phenanthrenes, and other minor radiolysis products. These mixtures have been characterized by mass spectral examination in the mass range from 226 to 686 and by number-average molecular weight determinations. Results of this study show that with continued exposure to radiation the number-average molecular weight of the high boilers increases and that the amount of material of mass >686 also increases. For OMRE operations, with high boilers removed to maintain a steady-state concentration of 30 to 40%, the number-average molecular weight leveled off at 600 ± 50. The more volatile components of the high boilers were examined by gas-liquid chromatography. Decomposition products through p-quinquephenyl were determined. The less volatile high boilers, called non-distillable high boilers, were partially separated by adsorption chromatography on alumina. Molecular weight determination, melting points, and ultraviolet spectra of the separated fractions gave interesting additional information about the high boilers. This experiment led to some important observations on the film forming ability of the coolant and to the development of a test, called the benzene dilution test, for measuring the film forming ability of the coolant. Finally, all the observations about the molecular weight distribution of the high boilers obtained during the course of this program are summarized and an estimate of the molecular weight distribution is presented. The estimate agrees well with the experimentally observed distribution. Discussions of difficulties and limitations of experimental techniques for materials in this mass range and data for reference hydrocarbons are given. (auth)

5942 (NASA-SP-58) EFFECT OF IONIZING RADIATION ON A SERIES OF SATURATED POLYESTERS. G. F. D'Alelio, Roland Haeberli, and George F. Pezdirtz (University of Notre Dame, Notre Dame, Ind.). 1964. 68p. $1.75 (OTS).

Studies are reported on radiation effects on selected saturated straight-chain and branched polyesters of diols and diacids. Intrinsic viscosity-dose relations were derived, and the irradiation grafting of monomers onto the polyesters was also studied. The influence of structure, crystallinity, orientation, etc. on the radiation effects was determined. (D.L.C.)

5943 (RRL-147) QUARTERLY REPORT [ON RADIATION RESEARCH], JULY 1–SEPTEMBER 30, 1964. Fundamental Research No. 6041. (Mellon Inst. Radiation Research Labs., Pittsburgh). Oct. 5, 1964. Contract AT(30-1)-2110. 11p. (NYO-2310-3). Dep.(mn); $1.00(cy), 1(mn) OTS.

Research activities of the Mellon Institute Radiation Research Laboratories are summarized. Abstracts are included for one paper on radiation chemistry and summaries are presented on nine programs under investigation. Special interest is shown for the radiolysis of organic compounds, ESR studies of radicals produced in a flow system, methyl radical production in the radiolysis of aromatic hydrocarbons, instrument and equipment development and operation, iodine and hydrogen production in hexane–hydriodic acid solutions, and radiolysis of liquid argon–ethane solutions. (N.W.R.)

5944 (SGAE-CH-7/1964) DIE STRAHLENBESTÄNDIGKEIT VON ANTHRAZENÖL IM KERNREAKTOR BEI TEMPERATUREN BIS 350°C. (Radiation Stability of Anthracene Oil in a Nuclear Reactor at Temperatures up to 350°C). E. Proksch, F. Wiesinger, W. Szinowatz, and H. Eschweiler (Österreichische Studiengesellschaft für Atomenergie G.m.b.H., Seibersdorf). [1964]. 26p. Dep.

The irradiation of a VÖEST anthracene oil in a nuclear reactor (about 50% of the absorbed dose by γ radiation, 50% by fast neutrons) at temperatures between 150 and 350°C resulted in the following initial G-values for the decomposition of the anthracene oil: $G^{\circ}(-A) = 0.40$ (150–200°C); 0.41 (275°C); 0.45 (315°C); 0.57 (350°C). These values are only about 80% higher than the corresponding terphenyl G-values. Due to the lower molecular weight of anthracene oil and due to the different decomposition kinetics the percentual decomposition in the same radiation field of the anthracene oil is not higher than 35–50% at most compared with terphenyl. Similar values have been found for the production of radiolyse gases. In the range of up to 40% the radiolytic decomposition of anthracene oil may be well described by a second-order rate law. The high-boiling decomposition products formed show a number-average molecular-weight of about 525; i.e. about three times the molecular-weight of the oil used. The radiolytic gas is composed mainly by H_2 and CH_4; the H_2 fraction decreases with increasing temperature. (auth)

5945 (TID-21153) RADIATION CHEMISTRY OF ORGANIC SYSTEMS. Final Report, January 1, 1959–August 31, 1964. James A. Knight, Jr. (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Contract AT(40-1)-2490. 32p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Radiolysis mechanisms and products of cyanogen–toluene mixtures are discussed. Data are included on radiolysis of pure toluene. Other data and discussion are included on the radiolysis of neopentyl alcohol. (J.R.D.)

5946 (TID-21382) FISSION-FRAGMENT-INDUCED OXIDATION OF LIGHT HYDROCARBONS (thesis). Jer Ru Maa (Pennsylvania State Univ., University Park). June 1964. Contract [AT(30-1)-1710]. 228p. Dep.(mn); $6.00 (cy), 4(mn) OTS.

An investigation was conducted to probe some of the questions concerning radiation-chemical processes and to provide some data on the fission-fragment-induced oxidation of light hydrocarbons. A fairly rigorous analysis of the determination of the quantity of fission-fragment energy which is deposited in a reacting-fluid mixture, was made. The importance of free radical diffusion and dose rate on G-values and product distribution was examined theoretically and by experiment. Calculations using Kupermann's model for reaction and diffusion in the wake of an ionizing particle showed that diffusion is so rapid relative to reaction in gaseous media that the system can be treated as a homogeneous mixture of radicals and molecules. Further, it was shown that an extremely high dose rate would be required before radical concentrations would be high enough to make radical-radical combinations very probable. Hence, it was concluded that the high linear energy transfer of fission fragments relative to gamma rays should have little effect on a gaseous reaction, and also that dose rate should be unimportant over the range used in the experimental work. Two irradiation cells were constructed for use in an experimental test of the foregoing and to obtain data on radiation-induced oxidation of light hydrocarbons. Mixtures of methane–oxygen, ethane–oxygen, propane–oxygen, and ethylene–oxygen were placed in one of the cells containing a cylinder coated with enriched uranium oxide. The cell was exposed to neutrons from the nuclear reactor which caused some of the uranium to fission and release fission fragments to the surrounding gas mixture. The effect of the variables–temperature, pressure, oxygen content, total dose, and dose rate–was observed and the results are interpreted in relation to the current understanding of oxidation mechanisms and radiation-chemical processes. Total hydrocarbon reacted seldom exceeded ten mole percent. Oxygenated hydrocarbons produced in significant quantities included: methanol from methane–oxygen mixtures; methanol, ethanol, and acetaldehyde from ethane–oxygen mixtures; isopropanol, acetone and acetaldehyde from propane–oxygen mixtures; and acetaldehyde, ethanol, and isopropanol from ethylene–oxygen mixtures. A rather limited investigation of the effect of fission fragments on carbon monoxide–hydrogen mixtures was made. Results showed nothing of practical significance. A cell constructed for use in exposing gas mixtures to gamma rays was used for irradiating propane–oxygen mixtures. These data, when compared with the fission-fragment irradiation results, showed almost the same product distribution and propane G-values. If one assumes the same kind and distribution of molecular species in the gamma and fission-fragment tracks, then this similarity in experimental results supports the postulate that the reacting system can be considered homogeneous and that there is no effect of dose rate or linear energy transfer (LET) over this relatively large range. A limited investigation of the radioactivity residual in the gas mixture was made and there was an attempt to identify the radioactive species. It is quite probable that all of the radioactive materials except carbon-14, which is formed by neutron capture, could be removed by simple separation procedures. The fission-fragment-oxidation data were compared with thermal data obtained with the raining solids reactor. In general, it was found that the fission-fragment reactor tended to produce more carbon dioxide and oxygenated hydrocarbons with the same number of carbon atoms as the parent hydrocarbon than the raining solids reactor. Carbon monoxide, and oxygenated hydrocarbons with less number of carbon atoms than the parent hydrocarbon, predominate in the data from the raining solids reactor. (D.L.C.)

5947 (TID-21383) FISSION FRAGMENT AND NUCLEAR REACTOR IRRADIATION OF METHANE AND METHANE–HYDROCARBON MIXTURES (thesis). Carl Wiern Farley (Pennsylvania State Univ., University Park). Sept. 1964. Contract AT(30-1)-1710. 299p. Dep.(mn); $6.00(cy), 5(mn) OTS.

The principal objectives of the investigation were: (1) to develop experimental methods for studying fission-fragment irradiation of gases at varying temperatures and pressures with particular emphasis on dose measurement; (2) to investigate the effects of diluents such as hydrogen and free-radical scavengers on methane decomposition with fission fragments; (3) to gain a better understanding of the role played by unsaturates in the fission-fragment irradiation of methane; (4) to compare the effects of nuclear-reactor and fission-fragment radiation on the kind and distribution of products formed in the gas phase; and (5) to present experimental data for preliminary economic evaluation of a fission-fragment process for methane decomposition. Mixtures to be irradiated were placed in a chamber containing a cylinder coated with enriched uranium oxide. The chamber was exposed to neutrons from the Penn State Reactor which caused some of the uranium to fission and release fission fragments to the surrounding gas. The reactor-radiation apparatus was quite similar but contained no uranium-coated cylinder. Batch irradiations were carried out in both studies, and the irradiated gas was analyzed by gas chromatography. Hydrogen, gaseous hydrocarbons to C_5, and a viscous liquid composed mostly of C_{14} to C_{20} hydrocarbons are formed in gamma and fission-fragment irradiation of methane. The only difference noted between gamma and fission-fragment irradiated methane was in the concentration of unsaturated hydrocarbons. Some additional investigations, which concentrated on ethylene, indicated that radiation dose rate may be an important variable particularly at very high dose rates. Hydrogen would likely be present in a recycle system designed to irradiate methane; hence, hydrogen was added to methane in the batch irradiations to show what might be expected in the recycle case. Results showed that the concentration of unsaturated hydrocarbons, which were found to be small when pure methane is irradiated, would be still smaller with hydrogen present. The studies with hydrogen and ethylene additions to methane indicated that the formation of products can be explained largely on the basis of well known free-radical reactions. In fact, it was possible to compute product distributions and relative G-values for the major compounds which were in satisfactory agreement with experimental data using a simple model based on a free-radical mechanism. Considerable data were obtained which should be useful for anyone attempting an economic evaluation of a chemonuclear reactor for methane conversion. (D.L.C.)

5948 (TID-21388) IRRADIATION OF HALOGENATED ALKENES: REACTION PRODUCTS AND MOLECULAR WEIGHT DISTRIBUTIONS. (thesis). Harry L. Cornish, Jr. (Vanderbilt Univ., Nashville. Graduate School). May 1964. Contract AT(40-1)-1327. 127p. Dep.(mn); $4.00(cy), 2(mn) OTS.

This investigation consisted of the irradiation of selected halogenated alkenes. Vinyl chloride, cis- and trans-dichloroethylene, trichloroethylene, tribromoethylene, and 2,3-dichloropropene were chosen because of their obvious structural similarities. The effects of ionizing irradiation were observed with regard to the influence of substitutional variations, sources of energy, and the irradiation phase. Two sources of irradiation were employed. Gamma rays were produced by the radioactive decay of ^{60}Co. These rays possess an energy of 1.25 Mev and were available at a dose rate of approximately 2.12×10^{17} electron volts per minute per gram of water. The other source of energy was an x-ray unit which produced rays with an effective energy of 20 kev and at an intensity of 2.62×10^{21} electron volts per hour. The reaction rates were expressed in terms of a G-value. Vinyl chloride, cis- and trans-dichloroethylene, trichloroethylene, and tribromoethylene were irradiated in the liquid phase in the cobalt-60 unit. Trichloroethylene and 2,3-dichloropropene in the liquid phase and vinyl chloride in the vapor phase were irradiated in the x-ray unit. Both liquid and gaseous products were analyzed by gas chromatography and infrared spectroscopy. Infrared

spectroscopy was also used to study the polymer structures formed. Number-average molecular weights were determined on the polymer products formed. Polymerization was observed to be the major reaction occurring in all the systems studied. Only in the case of the vapor phase irradiation of vinyl chloride by x rays was more than a trace of gas produced, and in this case only 10 to 15 per cent of the total products were gaseous. Irradiation of liquid vinyl chloride by gamma rays showed that this irradiation process involves an acceleration of the reaction rate as the exposure time is lengthened. G-values to 10,000 were obtained for the periods studied. This fact, along with a study of the products formed, shows that a chain propagation mechanism is favored. However, when vapor vinyl chloride is irradiated by x rays, much lower and constant G-values are obtained. The average G-value for seven runs was 26. Also, the polymer products are different and of a much smaller molecular weight. The molecular weights varied between 397 and 488 and appeared to be a function of the system pressure. Thus, the chain-propagation mechanism that dominates in the liquid phase irradiation is absent, or at least is only a minor reaction, in the vapor phase x-ray irradiation. The liquid phase irradiation of vinyl chloride, dichloroethylene, and trichloroethylene produced G-values which decreased as the number of chlorine atoms substituted was increased (10,000, 115, and 14 respectively). However, when the results of bromine substitution are studied, one finds a different effect. A G-value of 160 was obtained for liquid tribromoethylene. This shows that both the number of substitutions and the element involved must be considered. Comparison of the G-values obtained for the liquid phase gamma-ray irradiations of cis- and trans-dichloroethylene support the theory that the cis-isomers are slightly more reactive while the trans-isomers are more susceptible to polymerization. Cis-dichloroethylene had a G-value of 105 and trans-dichloroethylene had a G-value of 125. A crystalline polymer was formed in the liquid phase irradiation of both trichloro- and tribromoethylene. The trichloroethylene polymer crystal was separated by recrystallization in acetone. It was found to have a melting point of 210°C, a molecular weight of 667, and a carbon, chlorine, hydrogen ratio of 15.5 : 76.4 : 1. None of these purification techniques were successful on the tribromoethylene polymer crystals. X-ray irradiation of liquid 2,3-dichloropropene, which had a G-value of 52 and a polymer molecular weight of 580, and comparison of the G-value obtained with that recorded for the gamma-ray irradiations, substantiate the reports that both chain length and energy source have a definite influence on irradiation effects. This is also shown by the irradiation of trichloroethylene under the same conditions where a G-value of 31 was obtained. The liquid phase gamma-ray irradiation of cis- and trans-dichloroethylene and trichloroethylene produced polymers whose molecular weights did not change significantly with exposure time. The cis-dichloroethylene polymer had a molecular weight of 260, the trans-dichloroethylene polymer 415, and the trichloroethylene polymer 460. The trichloroethylene polymer from x-ray irradiation had a molecular weight of 380. The molecular weight of the polymer product from the liquid phase gamma-ray irradiation of tribromoethylene varied from 412 to 640, increasing as the exposure time was lengthened. In all of the irradiations, except the liquid phase gamma-ray irradiation of vinyl chloride, analysis of the G-values and reaction products supports the theory of a short-chain free-radical mechanism when unsaturated monomers are polymerized by ionizing irradiation. (auth)

5949 (TID-21389) THE EFFECTS OF IONIZING RADIATION ON PHENYL ACETYLENE, ETHYL ACETYLENE, 2,3-DICHLOROPROPENE, AND ETHYLENE (thesis). Lawrence William Utley, Jr. (Vanderbilt Univ., Nashville. Graduate School). Jan. 1964. Contract AT(40-1)-1327. 80p. Dep.(mn); $3.00(cy), 2(mn) OTS.

2,3-Dichloropropene was studied alone and in solution with benzene. Ethylene was studied alone and with addition of xenon. Phenyl acetylene, ethyl acetylene, and 2,3-dichloropropene were irradiated as liquids with ^{60}Co gamma rays. Ethylene vapor was the only compound irradiated with x rays. The x-ray tube used has an effective beam energy of 20 kev. The products of these irradiations were analyzed by gas-liquid chromatography and infrared spectroscopy. Liquid phenyl acetylene was found to have an average G value of 11, which is near the G value of 9 reported in the literature resulting from irradiation of phenyl acetylene with fast electrons. The principal reaction was the formation of a solid, polymer of reddish color, which is in agreement with the work cited. These G values are low compared with the G value for acetylene of 72. This high radiation stability of phenyl acetylene is believed to be attributable to its aromatic structure. In support of this, G for benzene itself is reported by Swallow to be less than 1. Irradiation of liquid ethyl acetylene gave an average G value of 186. The principal products were acetylene gas and a polymeric residue formed from the C_2H_4 fragment. Cochran found ethyl acetylene to have an average G value of 30 when irradiated in the vapor phase by x rays. Cochran found the principal reaction of radiation on ethyl acetylene vapor to be polymerization. Polymerization was found to be the principal reaction of radiation on all ethylene derivatives studied at Vanderbilt. Liquid 2,3-dichloropropene was found to have an average G value of 188, which agrees very closely with an earlier study of this compound at Vanderbilt. It was found that no appreciable energy was transferred between 2,3-dichloropropene and benzene when 2,3-dichloropropene was irradiated in solution with benzene. Benzene does, however, have a "protective" effect in the hydrogen yield from irradiation of cyclohexane in solution with benzene. Manion and Burton explained this effect as transfer of excitation energy from cyclohexane to benzene. An initial study of the irradiation of ethyl acetylene in solution with benzene likewise indicated no energy transfer. Ethylene vapor was irradiated alone and with admixture of xenon. The average G value was found to be 36. Earlier work at Vanderbilt found an average G value of ethylene vapor to be 30. This present study included analysis of gas products with gas chromatography, which was not available for the earlier investigations. Addition of xenon produced a marked increase in the reaction rate. The pressure drop due to the energizing of ethylene by xenon accounted for about 90 per cent of the total pressure drop after xenon was added. The reaction rate due to xenon in all investigations at Vanderbilt was found to be approximately proportional to the ratio of the cross section for energy absorption of the noble gas to the compound studied. (D.L.C.)

5950 INVESTIGATIONS IN THE FIELD OF RADIATION-INDUCED SOLID STATE POLYMERIZATION. II. N-VINYL-SUCCINIMIDE. Gy. Hardy and J. Varga (Technical Univ., Budapest). Acta Chim. Acad. Sci. Hung., 40: 419-30(1964).

Solid-state polymerization and post-polymerization of N-vinyl-succinimide was investigated. Thermal effects were measured by differential thermoanalysis. This proved that the polymerization really takes place in the solid state. According to the results, two cases can be distinguished in radiation solid-state polymerization and post-polymerization, depending on such parameters as temperature, dose rate and sample dimensions: the case of thermaly steady state polymerization and the case of thermal explosion. On the bases of kinetic curves some expressions were found which can satisfactorily describe the first stage of polymerization and the induction period of the thermal explosion. (auth)

5951 THE CHEMICAL EFFECTS OF RADIOPHOSPHORUS RECOILING FROM NUCLEAR REACTIONS. M. Halmann (Weizmann Inst. of Science, Rehovoth, Israel). Chem. Rev., 64: 689-702(Dec. 1964).

The results of radiative thermal neutron capture in gaseous and liquid phosphorus compounds indicated that primary retention does not occur to any appreciable extent. Experimental methods for the study of chemical effects of the nuclear recoil of phosphorus are described. (123 references) (M.C.G.)

5952 PHOTOLYSIS OF FREE RADICALS PRODUCED BY γ IRRADIATION OF SOME C_3 AND C_4 ALCOHOLS AT 77°K. Claude Chachaty (CEN, Saclay, France). Compt. Rend., 259: 2423-6(Oct. 12, 1964). (In French)

The photolysis at 2537 Å of free radicals formed by γ irradiation at 77°K of some C_3 and C_4 alcohols was studied by electron paramagnetic resonance. The alkyl radicals resulting from this photolysis react on the substrate molecules by taking away hydrogen atoms fixed on carbon atoms or taking part of the hydroxyl group. (tr-auth)

5953 STUDY OF THE IRRADIATION PRODUCTS OF CHLORIDES AND NITRATES OF IRIDIUM AND RHODIUM DICHLOROTETRAPYRIDINES. Fernande Larêze (Collège de France, Paris). Compt. Rend., 259: 2438-41(Oct. 12, 1964). (In French)

It was established that a solution of iridium dichlorotetrapyridine chloride is altered under the effect of light. The nature of this transformation was investigated. It was established that the solution of rhodium dichlorotetrapyridine chloride was also decomposed. (tr-auth)

5954 STABILITY OF FREE RADICALS INDUCED BY ^{60}Co-GAMMA RAYS IN DESOXYRIBONUCLEIC ACID. A. van de Vorst (Université, Liège and Institut d'Astrophysique, Cointe-Sclessin, Belg.). Intern. J. Radiation Biol., 8: 111-20(1964). (In French)

The decay of free radicals induced by ^{60}Co γ rays in polycrystalline samples of DNA was studied by electron spin resonance methods. Results are reported for irradiation under different gaseous atmospheres. The results showed that two different types of radicals were induced by irradiation in the presence of moist air but that the presence of water was necessary for recombination. The concentration of free radicals during the first 24 hr period after irradiation was shown to depend on the water content of the DNA samples. (C.H.)

5955 QUANTITATIVE E.S.R.-MEASUREMENTS OF RADIATION-INDUCED RADICALS IN NUCLEOSIDES. Adolf Mueller and Wolfgang Koehnlein (Kernforschungszentrum, Karlsruhe, Ger.). Intern. J. Radiation Biol., 8: 121-30(1964).

The nucleosides deoxycytidine · HCl, thymidine, deoxyadenosine, deoxyguanosine, deoxyuridine, bromodeoxyuridine, and iododeoxyuridine were irradiated as dry crystalline powders and investigated by electron-spin-resonance spectrometry. First derivative spectra of each substance were recorded at 9.4 kMc/sec after x and gamma-irradiation with a whole range of doses up to 10 Mr. Qualitative results obtained at about 100°K and 300°K include new structural details of spectra. Emphasis was placed on quantitative determinations. When obtained from the initial linear parts of dose-effect curves, G-values ranged from 0.4 to 1.4 after irradiation at room temperature. No considerable differences from these values were found at low temperature but no warming up to room temperature about half of the radicals disappeared irreversibly. Departure of radical-concentration from a linear dependence on radiation dose occurred above 1 Mr at all temperatures for the nucleosides investigated. (auth)

5956 QUANTITATIVE E.S.R.-MEASUREMENTS OF RADIATION-INDUCED RADICALS IN NUCLEOTIDES. Adolf Mueller (Kernforschungszentrum, Karlsruhe, Ger.). Intern. J. Radiation Biol., 8: 131-40(1964).

The nucleotides deoxycytidine-5′-monophosphate, thymidine-5′-monophosphate · Ca, deoxyadenosine-5′-monophosphate · NH_4, and deoxyguanosine-5′-monophosphate · Na_2 were irradiated as dry crystalline powders at room temperature and subsequently investigated by electron-spin-resonance spectrometry. First derivative spectra of each substance were recorded at 9.4 kMc/sec after doses of x and gamma-rays up to 10 Mr had been given. Qualitative results include new structural details of nucleotide spectra, and these exhibit a close resemblance to spectra of nucleosides containing the same base. G-values determined from the initial linear parts of curves showed radical-concentration against radiation dose-range from 2 to 5. Departure from linearity occurs at about 1 Mr. Results on nucleotides, nucleosides, nucleic acid bases, and D-2-deoxyribose are compared. While the spectral hyperfine structure is characteristic of the nucleic acid bases, G-values and dose-effect curves for radical-concentration are typical of the pentose moiety. This result is tentatively explained by fast radical-transfer from the ribose to the base. (auth)

5957 QUANTITATIVE E.S.R.-MEASUREMENTS OF RADIATION-INDUCED RADICALS IN NUCLEIC-ACID BASES AND PENTOSES. Wolfgang Koehnlein and Adolf Mueller (Kernforschungszentrum, Karlsruhe, Ger.). Intern. J. Radiation Biol., 8: 141-56(1964).

Cytosine, 5-methylcytosine, 5-hydroxymethylcytosine, thymine, uracil, 5-bromouracil, adenine, hypoxanthine, guanine, xanthine, D-ribose, and D-2-deoxyribose were irradiated as dry crystalline powders at about 100°K and 300°K and investigated by electron-spin-resonance spectrometry. First, derivative spectra of each substance were recorded at 9·4 kMc/sec after x and gamma-irradiation with a whole range of doses up to 10 Mr. Qualitative results include new structural details of spectra confirming the richness of hyperfine structure in methyl containing compounds, but emphasis has been placed on quantitative determinations. G-values obtained from the initial linear parts of dose effect curves range from 0.1–1.0 for bases and 4 to 6 for pentoses after irradiation at room temperature. Although somewhat higher radical yields are often found if irradiations and measurements are executed at low temperature, these yields always decrease on warming-up to room temperature below the values given above. After irradiation at room temperature, the radical-concentrations in all bases lacking a methyl group deviate from a linear dependence on radiation dose above 0.3 Mr and attain a constant level, although linearity up to at least 1 Mr is observed with bases containing a methyl group and with pentoses. At low temperature linearity is found up to 1 Mr for all bases and pentoses except 5-bromouracil, for which the corresponding value is 0.5 Mr. (auth)

5958 ELECTRON-SPIN-RESONANCE STUDY OF RADIATION-INDUCED RADICALS IN AROMATIC AND ALIPHATIC AMINO ACIDS AND PEPTIDES. G. Casteleijn (Rijksuniversiteit, Utrecht), J. Depireux, and A. Mueller. Intern. J. Radiation Biol., 8: 157-64(1964).

Electron-spin-resonance spectrometry at room and at low temperature (100°K) was used to determine the free-radical yield in the x irradiated dipeptide glycylglycine, and the aromatic amino acids L-tyrosine and L-tryptophane. Molecular mixtures of L-tyrosine and glycylglycine, as well as L-tryptophane and glycylglycine prepared by freeze-drying of aqueous solutions, have also been studied by this method. The quantitative results obtained with the latter do not support the idea of intermolecular transfer of radicals or excitation energy between the different constituents of the mixtures. As opposed to this, when the aromatic amino acids are bound to glycine by a peptide bond to form glycyl-L-tyrosine and glycyl-L-tryptophane, a marked protection of the aliphatic chain by the aromatic ring system is observed. (auth)

5959 SPECTROPHOTOMETRIC DETECTION OF HYDRATED ELECTRONS IN Co^{60} γ-RAY IRRADIATED SOLUTIONS. Sheffield Gordon and Edwin J. Hart (Argonne National Lab., Ill.). J. Am. Chem. Soc., 86: 5343-4(Dec. 5, 1964).

The feasibility of direct spectrophotometric determination of e^-_{aq} in ^{60}Co gamma-irradiated solutions was demonstrated. It was found that the optical density of a 0.001N sodium hydroxide solution saturated with hydrogen increases perceptibly at 7200Å upon exposure to gamma rays. The absorption disappears on removal of the gamma source. By measuring the intensity of absorption in the region from 4000 to 9000Å, an absorption spectrum identical with that found in the pulse radiolysis of water was obtained. When the solution was acidified, no transient absorption was found at 7200Å. Thus it was concluded that this transient species is the hydrated electron. Under the

conditions of irradiation the optical density change corresponded to an e^-_{aq} concentration of 1.4×10^{-6} M. Applications of this method are discussed. (M.C.G.)

5960 ON THE MECHANISM OF HYDROGEN EVOLUTION FROM IRRADIATED SOLUTIONS OF ETHANOL AND FORMATE IN WATER AND HEAVY WATER. Chava Lifshitz and Gabriel Stein (Hebrew Univ., Jerusalem). J. Chem. Soc.: 3811-15(Oct. 1964).

Aqueous solutions of ethanol and formate were irradiated with 200-kvp x rays. The water and/or the organic solute were isotopically labeled. The dependence of the yield and isotopic composition of the hydrogen evolved on the concentration of added hydrogen and phosphate ions was investigated. The results indicate that the solvated electrons, $e^-_{aq.}$ formed in irradiated water are converted to H atoms by $e^-_{aq.} + H_3O^+ \rightarrow H + H_2O$ and $e^-_{aq.} + H_2PO_4^- \rightarrow H + HPO_4^{2-}$. There was no evidence for the reaction $RH_2 + H_2^+ \rightarrow RH_2^+ + H_2$ in H_2SO_4 solutions of concentration <0.8 N. (auth)

5961 RADIATION CHEMISTRY OF CARBOHYDRATES. PART XIV. MECHANISM OF DEGRADATION OF D-SORBITOL DURING γ-IRRADIATION IN AQUEOUS SOLUTION. G. O. Phillips and K. W. Davies (University Coll., Cardiff, South Wales). J. Chem. Soc.: 3981-90 (Oct. 1964).

Paper chromatographic and radioisotopic methods were used to examine the γ radiation degradation of D-sorbitol in oxygen and in vacuo under a variety of conditions. Greater degradation occurs at pH 1.4 (initial –G 4.8) than in neutral conditions (initial –G 3.5). This increase is mainly due to an increase in hexose production. The disappearance of D-sorbitol is of first order in solute concentration. The effect of oxygen, variation in pH, solute concentration, and the addition of potassium iodide as a radical scavenger were examined. The results cannot be satisfactorily interpreted solely in terms of H atoms and OH radicals produced by the radiation action on water and point to possible contributions from direct-action type processes at solute concentrations as low as 10^{-3} moles/l. (auth)

5962 THERMAL-NEUTRON CAPTURE IN GASEOUS AND LIQUID PHOSPHINES. PART III. MECHANISM OF FORMATION OF PHOSPHORUS-32-LABELLED RECOIL PRODUCTS. M. Halmann and L. Kugel (Weizmann Inst. of Science, Rehovoth, Israel). J. Chem. Soc.: 4025-8 (Oct. 1964).

In the radiative thermal-neutron capture in gas mixtures containing phosphine and methane, about 50 ± 10% of the resulting phosphorus-32 was in the form of phosphine. This retention of [^{32}P]phosphine was not decreased by addition of various rare gases which should act as moderators for hot phosphorus atoms. Addition of compounds that could possibly scavenge thermal phosphorus atoms had no effect on the retention. This independence of yield on reaction conditions seems to indicate that hot phosphorus atoms are unable to form stable products, and that phosphine itself (the target material) is a very efficient scavenger for thermal phosphorus atoms. (auth)

5963 STUDY OF THE LUMINESCENCE ACCOMPANYING THE DISSOLUTION OF SODIUM CHLORIDE IRRADIATED BY THE γ RADIATION FROM COBALT 60. Bernard Lelievre and Jean-Pierre Adloff (Centre de Recherches Nucleaires, Strasbourg). J. Phys. (Paris), 25: 789-96(Aug.-Sept. 1964). (In French)

The emission of light accompanying the dissolution of NaCl irradiated with ^{60}Co gamma rays in a solution of TlCl was studied. An initial light pulse of 30 msec was observed, followed by a second pulse lasting several seconds. The variation of the emission with TlCl, H^+, NO_3^- concentration; and NaCl grain size and mass was investigated. The luminescence was attributed to formation and excitation of the complex $TlCl_7^-$. The variation of F-center density with the radiation dose was also considered. (D.C.W.)

5964 SOME EFFECTS OF GAMMA RADIATION ON THE COMPOSITION OF THE SOIL SOLUTION AND SOIL ORGANIC MATTER. H. J. M. Bowen and P. A. Cawse (Atomic Energy Research Establishment, Wantage, Berks, Eng.). Soil Sci., 98: 358-61(Dec. 1964).

The composition of the solutions extracted from two soils were altered by treatment with 5 Mr of gamma radiation. The bulk of the carbon, nitrogen, and inorganic elements set free by irradiation are thought to have arisen from the lysis of microbial cells. Manganese is increased by other processes, probably involving reduction of insoluble oxides. Much of the magnesium, nitrogen, and phosphorus present in soil solutions after irradiation is organically bound. The composition of the soil solution is a more sensitive index of radiation damage than the changes in exchangeable nutrients. (auth)

5965 ON THE STUDIES OF MEASUREMENT OF DOSE OF γ-RAY BY IODIDES MIXED IN PLASTIC FILMS. Masao Isozaki, Noboru Ishikawa, and Yoshio Minoshima. Tokyo Kogyo Shikensho Hokoku, 59: 358-64(Aug. 1964). (In Japanese)

Films made of plastics that contain various metal iodides or organic iodides were irradiated by γ rays. The films thus irradiated had a maximum absorption of light at the wavelengths of 290 and 360 mμ and the optical density of the film increased proportionally with the gamma dose. Acetyl cellulose, polyvinyl acetate, polyvinyl alcohol, and gelatin were examined as the plastic films, which retain iodides. Cellulose acetate and polyvinyl acetate were the most sensitive, and gelatin and polyvinyl acetate were the least sensitive to the changes in optical density by irradiation. Potassium iodide, zinc iodide, cadmium iodide, p-benzoic acid iodide, acetic monoiodide, and tetraethylammonium iodide were examined. Zinc iodide was the most sensitive and potassium iodide and cadmium iodide were less sensitive than zinc iodide when mixed in the cellulose acetate film. Generally speaking, iodide of organic compounds had poor sensitivity but tetraethylammonium iodide has a same sensitivity as potassium iodide. Iodides mixed in cellulose acetate film had a good durability before irradiation and good heat resistance. Potassium iodide mixed in cellulose acetate film did not give any change in optical density measured before and after heat treatment until 140°C, and zinc iodide and cadmium iodide did not give any change until 120°C. The fading of optical density after irradiation was rather large. (auth)

5966 INFLUENCE OF THE EXPOSURE-TEMPERATURE ON γ-RAY SENSITIVITY OF NUCLEAR EMULSIONS. Masami Kawasaki, Takaaki Otsu, and Etsuo Fujii. Tokyo Kogyo Shikensho Hokoku, 59: 365-73(Aug. 1964). (In Japanese)

The effects of ^{60}Co γ irradiation on commercial nuclear emulsions were studied at temperatures from −75 to 50°C. The exposed emulsions were developed with ID-19 type developer (1:2) at 20°C for 15 or 20 minutes without agitation. Sodium ammonium thiosulfate solution was used as a fixer. The fixing time was 30 minutes for an emulsion layer of 15μ thickness and 90 minutes for one of 50μ thickness. The densities of emulsion exposed were measured by the Macbeth-Ansco color densitometer. Among the emulsions used, in the case of proton-sensitive emulsions, the densities were proportional to the dose of γ radiation in the range from 3.75 to 30 R for some, but the range varied from 22.5 to 120 R for others, and in the case of electron-sensitive emulsions, the range observed was from 167 to 835 mR. Reduction of the density by changing of irradiation was more effective on proton-sensitive emulsions than on the electron-sensitive ones. The densities of proton-sensitive emulsions exposed to γ rays were shown to be at a maximum at a temperature above 0°C, and those of electron-sensitive ones at a temperature below 0°C. (auth)

5967 EFFECTS OF IONIZING RADIATION ON THE SYSTEM SULFUR DIOXIDE-OXYGEN. II. THE OXIDATION OF SULFUROUS ACID TO SULFURIC ACID UNDER THE EFFECTS OF X RADIATION. THE G-VALUE DETERMINATION. Richard Schrader and Siegfried Schoenherr (Institut für Anorganische und Analytische

Chemie, Freiberg i. B.). Z. Anorg. Allgem. Chem., 331: 289-97(Sept. 1964). (In German)

Sulfurous acid in aqueous solution was oxidized to sulfuric acid in a special apparatus by irradiation with x rays (180 kv, 15 mamp, filtration 0.5 mm Fe); dose rate $(3.0 \pm 0.2) \cdot 10^{16}$ ev/ml · min). It is shown by way of example that in the beginning of the reaction about 500 molecules of sulfuric acid are produced per 100 ev of energy absorbed ($G(H_2SO_4) = 510 \pm 30$). (auth)

5968 EFFECTS OF IONIZING RADIATION ON THE SYSTEM SULFUR DIOXIDE-OXYGEN. III. OXIDATION OF SULFUROUS ACID TO SULFURIC ACID UNDER THE EFFECTS OF X RADIATION. INFLUENCE OF CONCENTRATION, TEMPERATURE, AND FOREIGN IONS. Richard Schrader and Siegfried Schoenherr (Institut für Anorganische und Analytische Chemie, Freiberg i. B.). Z. Anorg. Allgem. Chem., 331: 298-306(Sept. 1964). (In German)

The radiation chemical yield (G-value) of sulfuric acid oxidized from sulfurous acid was found to be dependent on the concentration of the sulfurous acid solution and its temperature. The reaction proceeded with marked consumption of oxygen. The radiation reaction was suppressed by addition of copper and iron ions. On the basis of the experimental results obtained a chain mechanism is proposed for the reaction. (auth)

5969 INVESTIGATIONS IN THE FIELD OF RADIATION CATALYSIS. V. I. Spizyn (Inst. for Physics and Chemistry, Academy of Sciences, USSR). Z. Physik. Chem. (Leipzig), 226: 360-90(1964). (In German)

The effects of radiation on catalysts and the catalytic effects of radiation are discussed and examples given. Dehydration of cyclohexanol in the presence of $MgSO_4$ + Na_2SO_4 labeled with ^{35}S is described. Data on the effects of the radioactivity on catalytic activity are presented in graphs. Dehydration of isopropyl alcohol with $Ca_3(PO_4)_2 \cdot H_2O$ labeled with ^{45}Ca and ^{32}P was also studied, along with catalytic dehydration of n-dodecyl alcohol on aluminum oxide in the presence of gamma radiation, fast electrons, or neutrons. (M.C.G.)

5970 ELECTRO-RADIATION CATALYSIS IN FUEL ELEMENTS. K. Schwabe (Technische Universität, Dresden and Zentralinstitut für Kernphysik, Rossendorf, Ger.). Z. Physik. Chem. (Leipzig), 226: 391-407(1964). (In German)

Studies on electro-radiation catalysis were carried out in connection with investigations of electrodes for fuel elements. Mechanisms of the cathodic reduction of oxygen and anodic methanol oxidation were investigated. The effects of electrodes impregnated with radioactive material or whose electrode material is radioactive on the rates of these reactions were determined. Data are presented in graphs for platinum, carbon, nickel, and silver electrodes. (M.C.G.)

5971 THE EFFECT OF IONIZING RADIATION OF A FAST ELECTRON FLOW ON POLYSULFOPHENYLENIC CATION EXCHANGERS. E. D. Kiseleva, A. V. Ragimov, K. V. Chmutov, A. A. Berlin, M. M. Klientovskaya, and T. A. Bryushkova (Inst. of Physical Chemistry, Academy of Sciences, USSR). Zh. Fiz. Khim., 38: 2316-19(Sept. 1964). (In Russian)

Effects of various doses of ionizing radiation on the weight, volume, and swelling of polysulfophenylene benzoquinone ionites (₹3, ₹4, and ₹S3) were investigated. Ionite stability under irradiation with fast electrons follows the pattern ₹3 > ₹4 > ₹S3. The quinone-hydroquinone group in the system exerts a protective effect against C–S bond breakage. (R.V.J.)

5972 IRRADIATION AND PRESSURE EFFECTS IN HALITE. Calhoun Ludlow Harper Howard. Thesis, New York, Columbia Univ., 1963. 77p.

Halite, when bombarded with x or gamma radiation, changes from colorless to orange-amber, its characteristic F-center coloration. Laboratory pressure experiments with halite crystals demonstrate that within limits a given exposure time increases the intensity of coloration in proportion to the concentration of deformational pressure-induced lattice defects. In an attempt to distinguish strongly strained from essentially unstrained halite, samples from domal and sedimentary localities were irradiated and the coloration intensities measured with a spectrophotometer. Large differences in colorability were not detected, since the halite crystal lattice reacts elastically to deformational stresses, thus effectively removing most of the lattice defects by spontaneous recrystallization. Although the total of the residual lattice defects is small, the effect can be detected by x irradiation and measurement of coloration intensity. Four major occurrences of halite can be delineated by this technique: (1) sedimentary deposits of well-crystallized halite with minimum lattice defects; (2) recrystallized halite from salt dome localities; (3) highly deformed halite from salt anticlines, stocks, folds, and fault localities; (4) highly deformed domal halite. The characteristic amber F-center coloration in halite rarely occurs in nature. Instead, remarkable deep blue and occasionally purple forms of halite occur, associated with potassium minerals. Data suggest that this coloration in natural halite may be attributed to gamma-ray bombardment, possibly by associated potassium-40 from sylvite, accompanied or followed by structural deformation. This work indicates that application of pressure prior to irradiation induces defects which enhance F-center coloration, but pressure applied after irradiation causes a change from amber F-center coloration to blue. (Dissertation Abstr., 25: No. 2(Aug. 1964))

5973 RADIATION INDUCED GRAFT COPOLYMERS OF CELLULOSE. Robert Yi-Ming Huang. Thesis, Toronto, Univ. of Toronto, 1963. 213p.

The radiation graft copolymerization of vinyl monomers onto cellulose using gamma-rays from cobalt-60 and the properties of the graft copolymers formed were studied. Cellulose-styrene graft copolymers were prepared by irradiating cotton cellulose swollen with styrene by a solvent exchange method. The structure of the graft copolymers was characterized by hydrolyzing away the cellulose substrate, isolating the grafted polystyrene side chains, and determining their molecular weights. It was found that on the average, only 1 in 10-20 cellulose chains carried a grafted polystyrene. The average molecular weights of the grafted polystyrene chains were approximately 500,000. Graft copolymerization of styrene onto cellulose is postulated to occur through cellulosic free radicals formed by gamma irradiation. Data for the radiation polymerization of styrene and methyl methacrylate in bulk at a radiation dose-rate of 1.42×10^6 rads/hr were obtained. The effect of ethanol, methanol, acetic acid, acetone, benzene, and water additive on the radiation polymerization of styrene was studied. The effect of swelling agents on the direct radiation grafting of styrene onto rayon and cotton yarn was investigated. By pre-swelling cellulose with water or non-aqueous organic swelling agents such as formic acid, formamide and dimethyl sulfoxide and then irradiating in styrene or styrene/solvent mixtures, grafting onto cellulose occurred very readily. The amount of grafting obtained depended on the swelling agent content in the cellulose and on the radiation dose. Methyl methacrylate, methyl acrylate and binary monomer mixtures of styrene-methyl methacrylate and acrylonitrile-methyl methacrylate were grafted onto rayon by applying the pre-swelling method developed for styrene grafting. Physical and tensile properties of rayon-styrene graft copolymers are presented. (Dissertation Abstr., 25: No. 2(Aug. 1964))

5974 PHOTON-ADSORBED GAS INTERACTION: DESORPTION. Richard Owen Adams. Thesis, Pullman, Wash., Washington State Univ., 1964. 62p.

It is observed that carbon monoxide is desorbed from iron, nickel, and zirconium by irradiating the metal surface on which the gas is adsorbed with photons having wavelengths of from 2000 to 6000 Å. A wavelength dependence on the desorption efficiency is observed. Maximums in the desorption occur at 2700 Å for nickel, at a wavelength less

than 2500 Å for zirconium, and in the visible region for iron. Photodesorption of nitrogen, hydrogen, and carbon dioxide from these metals was not observed to occur for radiation in the region of the spectrum used. Photodesorption from tungsten and molybdenum was also not observed. (Dissertation Abstr., 25: No. 2(Aug. 1964))

5975 THE ORGANIC PRODUCTS OF THE RADIOLYSIS OF PERFLUOROCYCLOHEXANE AND PERFLUOROCYCLOHEXANE-CYCLOHEXANE MIXTURES. R. J. Hanrahan and M. B. Fallgatter (Univ. of Florida, Gainesville). 8p. (CONF-571-20)

From American Chemical Society 148th National Meeting, Chicago, Aug.-Sept. 1964.

Perfluorocyclohexane and perfluorocyclohexane-cyclohexane mixtures were irradiated in a ^{60}Co gamma irradiator at a flux of about 0.5 MRad/hr. The products of radiolysis were analyzed using comparative retention volumes in a flame ionization chromatograph or using a thermal conductivity gas chromatograph-mass spectrometer arrangement. The only major organic product in the radiolysis of perfluorocyclohexane was the cyclic dimer C_6F_{11}-C_6F_{11}. A number of other products were formed, but with yields an order of magnitude less than that of the dimer. The main products formed in the mixture were three possible dimers, the monohydrogenated fluorocyclohexane, and a product, the nature of which could not be unequivocally determined from the mass spectrum, but which appeared to be a dihydrogenated fluorocyclohexane, possibly gem-dihydrodecafluorocyclohexane, and which, in any event, is apparently a secondary product. A mechanism of formation of the major radiolysis products is formulated. (P.C.H.)

5976 IMPROVEMENTS IN OR RELATING TO THE POLYMERISATION OF ETHYLENE BY RADIATION. (to Compagnie Francaise de Raffinage). British Patent 971,978. Oct. 7, 1964. Priority date Apr. 6, 1962.

A method of polymerizing ethylene by ionizing radiation in the presence of ammonia is described. The polymerization is performed at a temperature not exceeding 130°C and preferably near ambient temperature. Between 3 and 10 mole % ammonia is needed. Gamma radiation from a ^{60}Co source is preferred, but other types of radiation may be used. The speed of the process is comparable to commercially used methods. After polymerization the residual ethylene and ammonia are separated from the polymerizate by simple degassing. The normally solid product obtained contains about 0.05% by weight of N, has a density of the order of 0.930 to 0.935 g/cm^3, a tensile strength of the order of 190 to 210 kg/cm^2, and a crystalline melting point of 110 to 125°C. The conversion rate may be improved somewhat by using extremely pure ethylene and ammonia. (A.G.W.)

Radiochemistry

5977 (NAS-NS-3007(Rev.)) THE RADIOCHEMISTRY OF CHROMIUM. J. Pijck (Ghent. Rijksuniversiteit). May 1963. 78p. "Nuclear Science Series" of the National Research Council. Committee on Nuclear Science. Dep.; $0.75(OTS).

A monograph is presented which gives the pertinent information required for radiochemical work with Cr. The nuclear and chemical properties of Cr are reviewed, and radiochemical methods and procedures are discussed. (D.L.C.)

5978 DIFFUSION PRECIPITATION OF DECAY PRODUCTS OF RARE GASES IN A CIRCULAR OR PLANE CHANNEL. V. M. Berezhnoi and V. N. Kirichenko. At. Energ. (USSR), 17: 300-2(Oct. 1964). (In Russian)

A solution is given for the problem of diffusion of the atoms formed in a laminar gas flow through round or flat channels. Expressions obtained for the flow through the channel and the linear distribution of the surface density of atoms deposited on the walls can be used for the determination of diffusion coefficients of atoms of solids formed in the decay of radioactive rare gases and for the calculation of their precipitation in sampling pipes. (M.J.T.)

5979 SYNTHESIS OF ADENOSINE-^{14}C-8. SIMULTANEOUS FORMATION OF THE TWO α AND β NUCLEOSIDE ANOMERS BY THE FUSION METHOD. Louis Pichat, Philippe Dufay, and Yves Lamorre (CEN, Saclay, France). Compt. Rend., 259: 2453-6(Oct. 12, 1964). (In French)

Fusion under vacuum at 180°C of the mixture of N_6-acetyladenine-^{14}C-8 and tetra-0-acetyl ribofuranose, in the presence of p-toluenesulfonic acid, leads, after deacetylation, to the two anomers 9-α-D-ribofuranosyladenine-^{14}C-8 (42%) and 9-β-D-ribofuranosyladenine-^{14}C-8 (58%) with a total yield of 60%. The anomers were easily separated on an acetate form of Dowex 1 exchange resin. (tr-auth)

5980 TEMPERATURE DEPENDENCE OF THE ELECTRONIC SPECTRA OF INORGANIC SOLUTIONS OF URANYL SALTS. L. V. Volodko, A. N. Sevchenko, and D. S. Umreiko. Opt. Spectry. (USSR) (English Transl.), 17: 189-93(Sept. 1964). Translated from Optika i Spektroskopiya, 17: 356-63(Sept. 1964).

Results show that the absorption spectrum of uranyl compounds in the visible region is complex and consists of several spectra, each of which corresponds to a set of optical transitions to its own excited electronic state; and that the set of transitions between the first excited state and the ground state forms a luminescence spectrum and a long-wavelength absorption spectrum which possess mirror-symmetry properties. (N.W.R.)

5981 ON THE RADIOLUMINESCENCE OF ORGANIC SUBSTANCES. IV. THE α, β RATIO OF PLASTIC SCINTILLATORS. S. F. Kilin and I. M. Rozman. Opt. Spectry. (USSR) (English Transl.), 17: 230-3(Sept. 1964). Translated from Optika i Spektroskopiya, 17: 431-37(Sept. 1964).

The α, β ratio of plastic scintillators based on polystyrene with various luminescent additives was measured. The magnitude of the ratio depends on the individual properties of the additive and, for the majority of the compounds investigated, diminishes as the concentration increases. The results are interpreted on the basis of the concept of specific quenching in the radioluminescence process. (auth)

5982 SEPARATION OF STRONTIUM-90 AND YTTRIUM-90 BY THE THIN-LAYER CHROMATOGRAPHIC METHOD. Hiroshi Hamaguchi (Tokyo Univ.), Nagao Ikeda, and Aiko Iwasa. Radioisotopes (Tokyo), 13: 377-81(Sept. 1964).

A thin-layer chromatographic method was investigated for the carrier-free separation of ^{90}Sr and ^{90}Y with several kinds of adsorbents and developers. With the Wakogel B-0 layer (silica gel with no binder), ^{90}Sr was transferred farther than ^{90}Y by combining with ethanol – 10% ammonium thiocyanate (5 vol : 3 vol) or ethanol – 7M lithium nitrate (1 : 1). With the Wakogel B-5 layer (silica gel with 5% plaster of Paris), no separation of the nuclides was attained. With the Dowex 50 resin layer, ^{90}Y was transferred farther with 5% ammonium citrate solution of pH 3.8. The method has the advantage that carrier-free ^{90}Y can be prepared in a simple way and in a short while. (auth)

5983 PREPARATION OF OXYGEN-15 FOR THE STUDY OF PULMONARY FUNCTION. Harukata Baba (Institute of Physical and Chemical Research, Tokyo), Masaaki Iio, Kiyoshi Watanabe, Takashi Karasawa, Akira Shimamura, Masatake Henmi, and Toshihiko Inoue. Radioisotopes (Tokyo), 13: 389-92(Sept. 1964).

A short-lived radioactive isotope, oxygen-15, has been used for studying physiological lung function and the diagnosis in safety. It enables the route of local intake of oxygen in the lung and its clearance by the blood to be observed. Oxygen-15 was prepared by using air and 20 μA deflected 3.4-Mev deuteron beam from a 26-in. cyclotron. Oxygen-15 thus obtained has high specific activity and contains sufficiently small amount of radioactive contaminants, so that it could satisfactorily be used for clinical purposes. (P.C.H.)

5984 APPARATUS FOR THE COLLECTION AND PURIFICATION OF RADON. P. S. Rudolph (Oak Ridge National Lab., Tenn.). Rev. Sci. Instr., 36: 75-7(Jan. 1965). (ORNL-P-190)

A simple manually-operated apparatus for the collection and purification of radon is described. This apparatus uses a heated platinum filament to continuously reconbine the radiolytically produced electrolytic gas. The water vapor is condensed into the radium flask obviating the replenishment of water in the radium solution. The radon does not pass through any stopcocks. (auth)

Separation Processes and Procedures

Refer also to abstract 6042.

5985 (AERE-R-4516) THE REMOVAL OF PLUTONIUM AND CERTAIN FISSION PRODUCTS FROM ALKALINE MEDIA BY HYDRATED TITANIUM OXIDE. J. Kennedy, J. W. Peckett, and R. Perkins (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Sept. 1964. 19p. Dep.; $0.60(BIS), 3s.(HMSO).

The complexing and ion exchange properties of hydrated titanium oxide (HTO) and basic zinc carbonate (BZC) adsorbers are summarized. Distribution coefficients of plutonium(IV) and (VI) between flocs of the adsorbers and solutions of sodium carbonate have been measured at trace loadings as a function of $[Na_2CO_3]$. These are compared with similar results obtained for uranium(VI). Distribution coefficients of ruthenium (initially present in aqueous phases as nitro and nitrato complexes of RuNO(III)) have also been measured at trace loadings on HTO floc as a function of $[Na_2CO_3]$ and [NaOH]. Columns of granular HTO can adsorb 95% of trace ($\gtrsim 10^{-5}$ M) plutonium(IV) and trace zirconium and niobium from 2000 bed volumes in aqueous sodium carbonate media (0.1M and 0.5M). Adsorption of these species is not affected by the presence of uranium(VI) at 5 mg U/l in the aqueous phase. Between 80 and 85% of trace ruthenium (initially present as Ru(IV) and nitro and nitrato complexes of RuNO) is adsorbed from 2000 bed volumes in the same media by columns of HTO. Adsorption of ruthenium from sodium hydroxide media is poor—only 38% is adsorbed from 400 bed volumes when the ruthenium is initially present as nitro complexes of RuNO and none when initially present as nitrato complexes of RuNO. (auth)

5986 (HW-71589) LABORATORY STUDIES OF THE PRECIPITATION OF CERIUM SULFATE FOR OFF-SITE SHIPMENT. H. H. Van Tuyl (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 1, 1961. Contract AT(45-1)-1350. 5p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Several series of experiments were performed to determine the optimum conditions for precipitating cerium as the sulfate for loading into the cerium filter cask for off-site shipment. Two sets of conditions were determined to be optimum within the limitations imposed by plant equipment, one set for precipitation in the presence of tartrate to obtain additional purification of the cerium, and the other set in the absence of tartrate. Optimum conditions with tartrate are as follows: to one liter of feed, add 20 ml of 5 M tartaric acid and 500 ml of 2 M sodium sulfate; adjust to pH 0.5 to 1 with 50 percent sodium hydroxide; digest one hour at the highest temperature obtainable consistent with proper jet operation; centrifuge. In the absence of tartrate, the procedure is identical except that tartrate is omitted, and the pH range is 3 to 5. Loss with either procedure at 40°C is about 16 percent of the cerium. In either case, the precipitate may then be slurried with two liters of 0.5 M sodium sulfate, digested one hour as above, and filtered into the cask. Loss in the slurrying step is about ten percent of the original cerium when the precipitation and slurrying are both performed at 40°C. (auth)

5987 (HW-74036) REPORT OF INVENTION—IMPROVEMENTS OF STRONTIUM SULFATE PRECIPITATION PROCESS. H. H. Van Tuyl (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 18, 1962. Contract [AT(45-1)-1350]. 7p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A modification of the carrier precipitation process for the recovery of Sr from Purex wastes, is described in which the separation of Sr from Ce and other rare earths is improved. Besides the addition of sodium sulfate, alkali and lead nitrate, the process involves the addition of tartaric acid and H_2O_2 to the solution. Data are presented on the effects of peroxide, sodium sulfate, and tartaric acid on the sulfate precipitation. Possible mechanisms of the improved separation are discussed. (D.L.C.)

5988 (HW-75537) REPORT OF INVENTION—SOLVENT EXTRACTION PROCESS FOR RECOVERY OF STRONTIUM, CERIUM, RARE EARTHS, AND CESIUM FROM RADIOACTIVE WASTE SOLUTIONS. Lane Allan Bray (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 5, 1962. Contract [AT(45-1)-1350]. 14p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A solvent extraction process is described which removes Sr, Ce, Cs, and rare earths from acid solutions (pH 3 to 5) in one operation. The process is based on the use of a solvent composed of 4-sec-butyl-2-(α-methylbenzyl)phenol and di-2-ethylhexyl-phosphoric acid in a diluent such as SOLTROL-170. Data are presented on the extraction of Sr, Ce, and Cs by the process under varying conditions. (D.L.C.)

5989 (KFK-232) EISEN(III)-HYDROXID ALS AUSTAUSCHADSORBENS. Literaturübersicht. (Iron(III) Hydroxide as Exchange Adsorbent. Literature Search). Ludwig Lindner and Hans-Heiko Stamm (Kernforschungszentrum. Institut für Radiochemie, Karlsruhe, Germany). June 1964. 66p. Dep.(mn).

Literature published between 1900 and 1963 on iron(III) hydroxide as an ion exchange adsorbent was surveyed. The mechanism of fixation of ions on the iron hydroxide is discussed. The 139 references include short abstracts. (M.C.G.)

5990 (MITNE-50) EQUILIBRIUM EXTRACTION CHARACTERISTICS OF ALKYL AMINES AND NUCLEAR FUELS METALS IN NITRATE SYSTEMS. Progress Report XIII, October 1, 1963–May 30, 1964. Philip J. Lloyd and Edward A. Mason (Massachusetts Inst. of Tech., Cambridge). Aug. 3, 1964. For Oak Ridge National Lab., Tenn. Contract W-7405-eng-26, Subcontract 1327. 33p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The extraction of Cu and Ag was studied using radiotracers by extracting both metals simultaneously from a single aqueous phase. The extraction coefficient for silver was >0.1 at acid concentrations >8M, for 0.2M trilaurylamine in toluene. The copper extraction coefficient was at a maximum of 0.0005 from 3M nitric acid, for the same amine concentration. Gold extraction was studied using a radiotracer from pure nitrate solution, a gold foil after irradiation being dissolved electrolytically. The distribution coefficient was at a maximum of 40 at 3M nitric for 0.2M amine nitrate in toluene. An alternative technique for studying the simultaneous extraction of two metals, based upon the variation of distribution ratio with phase ratio, is discussed. The extraction of the nitrato complexes of nitrosylruthenium was studied. Within the narrow range of delay times so far examined, the species appear to be hydrolyzed according to first order kinetics with rate constants $k_1 \approx 0.08$ per min for the less extractable species, and $k_2 = 0.20$ per min for the more extractable species. The net increase in the number of nitrate ions transferred to the organic phase for each ruthenium transferred was studied. More than 3 nitrate ions were transferred in each case, and the calculations indicated that there was an increase of 5 nitrate ions for each of the less extractable species, and 3 nitrate ions for each of the more extractable species. If this is correct, the less extractable species appear to be polynuclear. The computer pro-

gram for analysis of mole fractions andpartition coefficients is described. (auth)

5991 (MITNE-54) EQUILIBRIUM EXTRACTION CHARACTERISTICS OF ALKYL AMINES AND NUCLEAR FUELS METALS IN NITRATE SYSTEMS. Progress Report XIV, June 1–August 31, 1964. Philip J. Lloyd and Edward A. Mason (Massachusetts Inst. of Tech., Cambridge). Oct. 24, 1964. For Oak Ridge National Lab., Tenn. Contract W-7405-eng-26, Subcontract No. 1327. 22p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Further tests were carried out on the technique of studying the variation of overall distribution ratio as a function of phase ratio in order to determine the partition coefficients of two species being extracted simultaneously. ^{75}Se and ^{111}Ag tracers were extracted from 1, 3, 6, 9, and 12M nitric acid solutions by 0.1 and 0.2M amine nitrate solutions. Significant results were only obtained at the highest acid and amine concentrations. Further studies of the behavior of nitrato complexes of nitrosylruthenium were made using the PARTIFRAC analysis of the variation of overall distribution ratio with phase ratio to determine the mole fractions of the extractable species. Hydrolysis rates in 3 M HNO_3 were extended; the less extractable species showed a rate constant for hydrolysis $k_1 \approx 0.01$ per minute, and the more extractable a rate constant $k_2 \approx 0.10$–0.15 per minute, though there is some evidence that the more extractable species are actually two, rather than one species, with different rates of hydrolysis. Back extraction experiments showed that in the organic phase, the less extractable species 1 was converted to the more extractable species 2, with a rate constant $k \approx 0.075$ per min. Attempts to observe the rates of nitration by dissolving $RuNO(NO_3)_3$ failed as it appeared that the preparation was a mixture containing at least 20% of the ruthenium as species 2. Attempts to prepare radioactive nitrosylruthenium nitrato species by solution in nitric acid of irradiated $RuNO(OH)_3$ also failed, as approximately 50% of the active ruthenium present in the final aqueous solution was evidently not a nitrosylruthenium complex. A tentative scheme for the extraction of the nitrosylruthenium nitrato complexes is outlined in which the probable structure of the complexes is suggested. The less extractable species appears to be the trinitrato complex, which is probably extracted with some coordinatively bound water. This water is then probably displaced during conversion of this species on standing in the organic phase. The more extractable species are probably predominantly tetranitrato nitrosylruthenium, with possible traces of the pentanitrato complex. (auth)

5992 (MLM-1201) A CRYOGENIC PROCESS FOR PURIFYING HELIUM-3. E. W. Wiederhold and B. D. Scearce (Mound Lab., Miamisburg, Ohio). May 25, 1964. Contract AT(33-1)-Gen-53. 9p. Dep.; $1.00(cy), 1(mn) OTS.

A cryogenic process was developed for removing gaseous impurities, except helium-4, from previously enriched helium-3. Vapor pressure versus temperature considerations indicated that less than 10^{-15} mole percent tritium gas would remain in equilibrium with its solid phase at 4.2°K in one atmosphere of helium-3. Therefore, a cold trap was designed to freeze tritium and other gaseous impurities (except helium-4) from helium-3 at the boiling point of helium-4 (4.2°K). Helium-3 (B.P. 3.2°K) which had been purified by thermal diffusion to about 10^{-6} mole percent tritium and more than 99 mole percent total helium was fed to the freeze-out chamber at a rate of one liter per minute. The chamber, cooled by a liquid helium-4 bath, was a 122-cubic centimeter copper pot loosely packed with silica gel to provide a large contact area for the feed gas. Low-level counting and mass spectrometer analyses showed that the product contained about 10^{-11} mole percent tritium and less than 0.1 mole percent total impurities. (auth)

5993 (NP-14447) INVESTIGATION AT KJELLER OF THE DECONTAMINATION FACTORS (D.F.'s) OF THE EUROCHEMIC FIRST EXTRACTION CYCLE FLOWSHEET. C. J. Joseph, M. Bonnevie-Svendsen, P. Svendsas, J. Centeno, A. Redon, and E. Detilleux (European Company for the Chemical Processing of Irradiated Fuels, Mol, Belgium). Apr. 1964. 33p. (ETR-165). Dep.(mn); $2.00(cy), 1(mn) OTS.

The results of the second series of runs done in the Reprocessing Pilot Plant at Kjeller (Norway), to test the performance of the first extraction cycle of the Eurochemic flowsheet for the decontamination of low enriched uranium fuels, are discussed and compared with those of the first series. A conservative extrapolation of the Kjeller operational data indicates that the decontamination factors for the first cycle, estimated for the design flowsheet (see ETR-78), will be easily achieved in the Eurochemic Plant. With the specified chemical conditions for the design flowsheet, the height (5 m) of the extraction section of the HA column appears to be just sufficient to achieve the specified plutonium recovery (99.8%), for which six theoretical stages will be required. However, theoretical calculations show that, by increasing the acidity of the feed solution (HAF) from 0.76 to 1.5M HNO_3, the required number of stages can be reduced to five. This practice can be a means of improving the plutonium recovery during plant operation if actual plutonium losses, using the design flowsheet, should prove to be higher than specified. Theoretical calculations of the uranium, nitric acid, and plutonium distribution in the different stages of the first extraction cycle are made, in order to check the Kjeller data and to extrapolate them to the Eurochemic equipment. (auth)

5994 (ORNL-3719) OFF-GASES FROM THE REACTIONS OF URANIUM CARBIDES WITH NITRIC ACID AT 90°C. L. M. Ferris and M. J. Bradley (Oak Ridge National Lab., Tenn.). Dec. 1964. Contract W-7405-eng-26. 21p. Dep.; $2.00(OTS).

The uranium carbides, UC, $U_4(C_3)_3$, and $UC_{1.85}$, dissolved in 2 to 16 M HNO_3 in 10 hr or less at 90°C, yielding off-gases comprised mainly of NO_2, NO, and CO_2. The off-gas compositions varied with the acid concentration: in dilute (2 to 4 M) acid, NO was the main nitrogen oxide present, whereas NO_2 predominated at higher acid concentrations. Traces of N_2O were found, but no CO, H_2, or gaseous hydrocarbons were detected. The carbides were almost completely passive in very dilute (0.001 to 0.5 M) acid. Between 30 and 50% of the carbide carbon was converted to species soluble in nitric acid irrespective of the carbide, reaction time, or variation of acid concentration between 2 and 16 M. (auth)

5995 (TID-21386) FREQUENCY RESPONSE OF SINGLE PHASE LONGITUDINAL DISPERSION AND TWO-PHASE EXTRACTION IN PACKED BEDS USING PULSE TESTING METHODS (thesis). Robert Gailor Justice (Vanderbilt Univ., Nashville. Graduate School). Aug. 1963. Contract [AT(40-1)-1327]. 168p. Dep.(mn); $5.00 (cy), 3(mn) OTS.

A study was made of the experimental frequency response of longitudinal dispersion in packed beds with and without mass transfer. Pulses of acetic acid in aqueous acetic acid solutions and in methyl isobutyl ketone–acetic acid–water systems were used in the study. The effects of flow rate, packing type, and column length were studied. Limiting solubility and distribution data are presented for the methyl isobutyl ketone–acetic acid–water system. Longitudinal dispersion coefficients ranged from 0.09 to 2.32 cm^2/ sec, and the frequency response data for the 2-in. dia column were found to fit the longitudinal dispersion model, while those for the 1-in.-dia columns using a slotted distributor did not. (D.L.C.)

5996 BIDENTATE ORGANOPHOSPHORUS COMPOUNDS AS EXTRACTANTS. II. EXTRACTION MECHANISMS FOR CERIUM(III) NITRATE. T. H. Siddall, III (E. I. du Pont de Nemours & Co., Aiken, S. C.). J. Inorg. Nucl. Chem., 26: 1991-2003(Nov. 1964). (TID-20036)

Mechanisms for the extraction of cerium(III) nitrate from nitric acid solutions were investigated. It was concluded that tetraamyl methylenediphosphonate (TAMDP) probably extracts trace cerium(III) nitrate by a mecha-

nism involving two molecules of extractant per cerium ion. However, extraction by dioctyl N,N-diethylcarbamylphosphonate (DODECP) and dihexyl N,N-dibutylcarbamylmethylenephosphonate (DHDBCMP) probably involves three molecules of extractant. Conditions necessary for a valid analysis of extraction data in terms of extraction mechanisms are discussed. (auth)

5997 REMOTELY OPERATED TRANS-PLUTONIUM CHEMICAL PROCESS CELLS. M. S. Coops, C. L. Hanson, L. R. Hawk, and V. E. Scribner (Univ. of California, Livermore). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 337-53.

Twenty-eight irradiated slugs containing gram-quantities of plutonium, americium, and curium have been processed successfully in a heavily shielded, remotely operated chemical facility utilizing pushbutton flow-process-control techniques. The chemical process, which is designed for trans-plutonium element processing, utilizes filtration, distillation, and ion-exchange techniques to separate the gamma-active actinide elements from the gross quantities of fission products produced during irradiation. The equipment operates at kilocurie alpha activity levels in the presence of corrosive chemical reagents, and is exposed to high beta and gamma radiation levels yet maintains confinement of the hazardous materials to the primary enclosures. Ventilation equipment includes refrigerated caustic scrubbers and multiple high-efficiency filters. (auth)

5998 ANION EXCHANGE BEHAVIOUR OF URANIUM, THORIUM AND LANTHANIDES IN ORGANIC SOLVENT MIXTURES. I. Hazan, S. S. Ahluwalia, and J. Korkisch (Univ. of Vienna). Z. Anal. Chem., 206: 324-31(1964).

The adsorption behavior of uranium, thorium, cerium, and terbium towards the strongly basic anion exchange resin Dowex-1 in mixtures of various organic solvents with acetone and methanol as the base solvents was investigated. The complexing acid in case of acetone was nitric acid while in the case of methanol, hydrochloric acid was used. Measurements of the distribution coefficients of these elements in such mixtures containing nitric acid as the complexing agent showed that in all cases a linear relationship between the adsorption and the concentration of acetone exists. Furthermore the relationship between the dielectric constants of the solvent mixtures and the adsorption of above elements was investigated. The results showed that the dielectric constant of the solvent mixture cannot be employed for predicting the degree of adsorption. (auth)

5999 PYROMETALLURGICAL DECONTAMINATION OF A MAGNESIUM–THORIUM ALLOY. James Stephen Klepfer. Thesis, Ames, Iowa, Iowa State Univ. of Sciences and Tech., 1964. 141p.

A fused salt-liquid metal scheme for decontaminating a Mg-40% Th alloy containing yttrium, alkali, alkaline earth, and lanthanide fission product elements by selective oxidation-reduction reactions is presented. A KCl-44.5% LiCl eutectic salt containing $MgCl_2$ is used to selectively oxidize those elements whose free energies of formation are greater than that of magnesium chloride. Yttrium and the lanthanide elements are effectively reduced from the salt in concentrated form by a Zn–Mg scrub alloy. The optimum reducing power of the scrub alloy was observed to be from 6 to 8% Mg in zinc. In general, both the oxidation and reduction reaction equilibria are more favorable at lower temperatures. The optimum magnesium chloride concentration in the salt depends upon the impurity composition of the Mg–Th, relative phase weights, allowable thorium loss, and overall extraction time. It is estimated that from 10 to 25% $MgCl_2$ will permit practical process design. Simultaneous contact of the three phases was made in a single-stage, batch extractor. At 600°C, decontamination of the Mg–Th to less than 20 ppm for each solute was attained in less than 10 hours. Thorium loss was very small. The concentration of magnesium in the scrub alloy can be controlled to the optimum range by adjusting the initial concentration and phase weight. The dynamic extraction data indicate that the level and time of decontamination can be significantly reduced by improvements in process design. (Dissertation Abstr., 25: No. 2(Aug. 1964))

6000 SAFE EVAPORATOR (Engineering Materials). (Dow Chemical Co. Rocky Flats Plant, Denver). (CAPE-1180)

Four drawings are included of an evaporator used to evaporate peroxide filtrate for concentrating plutonium solutions and destroying excess peroxide in Pu recovery. Included is a 5 in. ID by 30 in. long heat exchanger. (P.C.H.)

6001 PROGRESS TOWARDS AUTOMATED RADIOCHEMICAL SEPARATIONS. F. Girardi, M. Merlini, J. Pauly, and R. Pietra (EURATOM, Ispra, Italy). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/12, 14p. (CONF-641001-22)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

Work on the automation of radiochemical separations, which is being done in an attempt to give to this step the same degree of reliability and simplicity as that inherent in nondestructive analysis by gamma-spectroscopy, is discussed. Passage through chromatographic columns is the operation that was automated first. The different types of chemical reactions that can be done with that operation are described. These include ion exchange, partition chromatography, precipitation and dissolution, concentration, neutralization, and oxido-reduction. Automated equipment is described. The equipment is composed of a series of elementary units that can be connected in different ways in order to set up different separation schemes depending on the system under study. The results of the first experiences with actual samples are described and discussed. (P.C.H.)

6002 IMPROVEMENTS IN OR RELATING TO APPARATUS FOR CARRYING OUT CHEMICAL REACTIONS. Robert James Moulton and Roystan Frank Taylor (to United Kingdom Atomic Energy Authority). British Patent 971,050. Sept. 30, 1964. Filed Feb. 23, 1962.

The apparatus described is designed to permit fuel cans from a nuclear reactor to be contacted by a liquid adapted to dissolve the fuel and than removed. Solid bodies are fed into the upper part of a reaction column, which is connected at the lower end to a collecting box. A housing leading from the lower surface of the collecting box contains a perforated cone through which the bodies pass to a delivery conduct located below. A balancing column closed at the top and containing a suitable gas is provided above the collecting box. The apparatus is made of boron steel and requires a minimum of maintenance since there are no moving parts. (A.G.W.)

6003 IMPROVEMENTS IN OR RELATING TO APPARATUS FOR CARRYING OUT CHEMICAL REACTIONS. Robert James Moulton and Royston Frank Taylor (to United Kingdom Atomic Energy Authority). British Patent 971,188. Sept. 30, 1964. Filed Feb. 23, 1962.

The apparatus described is designed to permit fuel cans from a nuclear reactor to be contacted by a liquid adapted to dissolve the fuel and then removed. Solid bodies are fed into the upper part of the reaction column, which is connected at the lower end to a collecting box of such a shape and so located with respect to the reaction column that the solid bodies form a free surface therein. A discharge column leads from the collecting box from a position adjacent to and generally above the free surface. Pulses are directed to the free surface from below, by which the solid bodies are disturbed and urged toward and along the discharge column. If the discharge column is vertical, a series of steps is placed along it to prevent the return of the solid bodies. Alternatively, the discharge column may be horizontal or at an angle to the vertical. Fresh liquid for dissolution may pass down the discharge column countercurrent to the solid bodies. The apparatus is made of boron steel and a minimum of maintenance is required since there are no moving parts. (A.G.W.)

6004 SEPARATION OF AN ACTINIDE METAL FROM AN ALLOY. H. Pearlman and L. A. Hanson (to U. S. Atomic Energy Commission). U. S. Patent 3,158,468. Nov. 24, 1964.

A process for the separation of an actinide metal from thorium–magnesium, thorium–zinc, or uranium–zinc binary alloys is described. The actinide metal constituent is precipitated from the molten alloy by the addition of lithium metal. Upon completion of the precipitation, the actinide metal is filtered from the lithium–magnesium or the lithium–zinc alloy. (AEC)

6005 METHOD OF PURIFICATION OF PROMETHIUM-147. P. B. Orr, Jr. (to U. S. Atomic Energy Commission). U. S. Patent 3,161,463. Dec. 15, 1964.

Promethium and americium values contained in an aqueous solution were separated from each other by sorbing the values onto a cation exchange resin and selectively eluting the values with an aqueous solution of diethylenetriaminepentaacetic acid. (AEC)

ENGINEERING

General

Refer also to abstract 6500.

6006 (AFWL-TDR-64-67) FLARE ACTIVATED RADIOBIOLOGICAL OBSERVATORY SATELLITE. DESIGN STUDY DRAFT. Final Report. L. R. Lewis, W. E. Crosmer, et al. (Bendix Corp. Bendix Systems Div., Ann Arbor, Mich.). Aug. 1964. Contract AF29(601)-6001. 340p. (AD-607601). $7.30(OTS).

A satellite system design study was performed to determine the characteristics required of a satellite to evaluate the solar flare and radiation belt hazard to near-earth manned space missions. The study uncovered possible problem areas and investigated their solution. Scientific instrument payloads were selected to measure radiation parameters of significant importance. Trade-off studies among the system parameters were performed and system designs were recommended. A preliminary design was undertaken in each satellite subsystem area; two satellite designs were developed. The first was a sophisticated 450-pound satellite compatible with the Delta DSV-3B launch vehicle, and the second was a simplified 150-pound version compatible with the Scout (SLV-1A) vehicle. In addition, breadboard design studies were undertaken on the Power Supply and Solar Flare Detection Subsystem. (auth)

6007 (KAPL-M-6422) ANALYSIS OF SHEAR PINS UNDER SINGLE SHEAR. P. E. Duffy (Knolls Atomic Power Lab., Schenectady, N. Y.). Nov. 1964. Contract W-31-109-eng-52. 29p. Dep.(mn); $2.00(cy), 1(mn) OTS.

A shear pin is analyzed as a beam on an elastic foundation. It is shown that for commonly used materials, maximum pin length need not be any greater than twice its diameter. Non-dimensional design curves are given for pin bending stress, maximum bearing stress, lug stress, and pin deflections. Also the effect of tapering or chamfering the pin hole is given. (auth)

6008 (RFP-469) COMPARISON OF SOLVENTS FOR CLEANING METAL SURFACES. D. S. Irwin and T. C. Johnson (Dow Chemical Co. Rocky Flats Div., Golden, Colo.). Nov. 23, 1964. Contract AT(29-1)-1106. 12p. Dep.; $1.00(cy), 1(mn) OTS.

A solvent testing program was conducted to determine the best solvent for the cleaning operations at Rocky Flats. Trichloroethylene was found to be the most effective cleaning agent of all those that met the requirements. The ultrasonic-vapor degreasing combination cleaning method using trichloroethylene as the solvent was found to be more effective in removing residues from all part types than any of the methods used previously at Rocky Flats. This cleaning method was adopted for all parts cleaning operations at Rocky Flats. (auth)

6009 (SWRI-1228-40) FUNDAMENTAL INVESTIGATION OF LIQUID-METAL LUBRICATED JOURNAL BEARINGS. Quarterly Technical Report No. 2. Report RS-430. R. A. Burton and H. J. Carper (Southwest Research Inst., San Antonio). Oct. 1, 1964. Contract AT(11-1)-1228. 71p. Dep.(mn); $3.00(cy), 2(mn) OTS.

Hot-wire anemometer techniques are applied in the 6-ft bearing model to obtain preliminary friction coefficient and velocity profile data. Data which relate to Couette flow acting alone are also reported. Derivations are reported for both the extreme long bearing (plane flow) and for the extreme short bearing. In the case of the long full bearing the role of inertia in very large film thicknesses is discussed, and some evidence is offered to show its range of influence. (N.W.R.)

6010 (TID-21356) AN EXPERIMENTAL INVESTIGATION OF THE STRESSES AND DEFLECTIONS OF A PERFORATED PLATE IN BENDING. PART II. C. W. Brown (Tennessee. Univ., Knoxville. Engineering Experiment Station). Jan. 1963. For Oak Ridge National Lab., Tenn. Contract [W-7405-eng-26], Subcontract No. 875. 71p. (ME-63-1-1). Dep.(mn); $3.00(cy), 2(mn) OTS.

The average ligament stress and deflection variation along radial sections of uniformly loaded, clamped edge plates were measured for two types of triangular penetration patterns: (1) uniform-diameter holes and (2) superposition of large-diameter holes over small-diameter holes. The results for the uniform hole pattern were compared with these calculated using effective elastic constants in the "equivalent" solid plate concept, and best agreement was obtained using Sampson's constants. (D.L.C.)

6011 REMOTE ENCAPSULATION OF MEGACURIE AMOUNTS OF COBALT-60 AT BROOKHAVEN NATIONAL LABORATORY'S HIGH INTENSITY RADIATION DEVELOPMENT LABORATORY. Otto A. Kuhl (Brookhaven National Lab., Upton, N. Y.). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 177-82.

A total of 1.75×10^6 curies of cobalt-60 have been remotely removed from reactor encapsulations, double encapsulated in stainless steel envelopes, leak-tested, and calibrated. Previous papers described the High Intensity Radiation Development Laboratory (HIRDL) and equipment designed to perform these operations. Hot operations have in some instances required modification of this equipment and design of additional equipment. (auth)

6012 BETA CALUTRON-ION SOURCES (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1167)

Eighteen drawings are included for M-16 ion source used in Pu separation by calutron and in uranium and stable isotope separation. The ion source may be serviced in a glove box, and is compatible with existing plutonium containment. The source is used with charges ranging from 1g Pu (mixed with 17 g U) to hundreds of grams of stable isotope charge feeds. Ion output ranges from an average of 2 to 75 mA. The M-16/2 miniaturized source is used with pre-enriched feeds to obtain an increase in total recovery and process efficiency. The source is used with 10 to 100 g of charge material. (P.C.H.)

6013 EXPERIMENTAL PERFORMANCE OF A 50 CENTIMETER DIAMETER ELECTRON-BOMBARDMENT ION ROCKET. Paul D. Reader (Lewis Research Center, Cleveland). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-689, 14p, $1.00 (CONF-640801-1)

From 4th Electric Propulsion Conference, Philadelphia.

Scaling investigations of 5- to 20-cm-diameter thrustors were extended to 50-cm-diameter thrustors. A variable-flow propellant distributor and multiple cathodes were used to smooth the current density profile at the screen grid. Current density traces are presented. The qualitative performance of the 50-cm unit was similar to that of the smaller thrustors. Ion-chamber losses were significantly lower than the values extrapolated from small-thrustor data. Thrustor efficiency was 83% at the design conditions of a 9000-sec specific impulse, 0.11-pound thrust, and 21.5 kw of effective jet power. These conditions correspond to a 10,000-hr accelerator-electrode durability. Thick oxide-layer cathodes were substituted for the refractory units normally used and resulted in an increase in thrustor efficiency to 88% at the design conditions. The 0.11-pound thrust level was continuously maintained for 65 hr using oxide cathodes. Thrustor output could be maintained with two of the four cathodes at the expense of a few percent in thrustor efficiency. (auth)

6014 EFFECTS OF PLASMA NON-UNIFORMITY ON GRID EROSION IN AN ELECTRON BOMBARDMENT ION

ENGINE. Daniel J. Kerrisk and T. D. Masek (California Inst. of Tech., Pasadena). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-688, 28p, $1.00. (CONF-640801-4)

From 4th Electric Propulsion Conference, Philadelphia.

Selective erosion of the accelerator grid due to non-uniformity of the plasma was investigated, using a standard Kaufman-type engine with a constant perveance grid system. Measurements of plasma composition were made and correlated to the beam current distribution and sputtering rates measured at different locations on the grid. (D.C.W.)

6015 POWER CONDITIONING, SWITCHING, AND CONTROL FOR SPACE PROPULSION SYSTEMS USING ION THRUSTORS. D. D. Erway and S. L. Eilenberg (Electro-Optical Systems, Inc., Pasadena, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-680, 42p, $1.00. (CONF-640801-5)

From 4th Electric Propulsion Conference, Philadelphia.

Research on problems associated with matching the output of a large nuclear-electric power source to the requirements of contact ion thrustors is summarized. An analysis is presented of the factors which influence the design requirements and the technical approach to power conditioning, switching, and control (PCSC) subsystems. Thrustor requirements, power source characteristics, and environmental constraints are considered from the standpoint of their relation to power conditioning. In addition, the results of the development of a breadboard PCSC unit at a 30-kw power level are discussed. (auth)

6016 POWER CONVERSION AND CONDITIONING FOR 300-1200 kw PLASMA PROPULSION SYSTEMS. Rolf D. Buhler, R. E. Stribling, and R. A. Moore (Electro-Optical Systems, Inc., Pasadena, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-679, 95p, $1.00. (CONF-640801-8)

From 4th Electric Propulsion Conference, Philadelphia.

A preliminary study of power supply systems for continuous "arc-discharge-type" plasma engines was made. Measured static and dynamic voltage-current characteristics of ~30 to 60 kw and ~300 kw engines are presented and interpreted in terms of circuit elements required for proper stability and control of power input to the engine. The current-voltage output characteristic of a simple (variable voltage) inductor alternator, together with a rectifier bridge, is found to satisfy ideally the plasma engine requirements, with the alternator field held substantially constant and adjusted only for engine power control. Compared with previous (constant voltage generator-saturable reactor) concepts, this approach eliminates nearly all power conditioning weights and losses and permits a lighter generator (better power factor). Preliminary design, weight, and performance figures for a 300-kw, d-c plasma engine power supply were developed. (auth)

6017 EQUIPMENT AND CIRCUIT CONSIDERATIONS FOR PLASMA ARC JET ENGINES IN SPACE ENVIRONMENT. Robert Richter (General Electric Co., Cincinnati). New York, American Inst. for Aeronautics and Astronautics, 1964, Paper No. 64-678, 14p, $1.00. (CONF-640801-9)

From 4th Electric Propulsion Conference, Philadelphia.

The various considerations in the selection of the electrical equipment associated with the operation of electrothermal engines in a space environment are reviewed. The basic assumption is made that the electrical power supply will be of the three-phase type, being either the main power supply of a space vehicle or being solely the power source of a thermoelectric engine. A comparison of both systems is made with respect to weight advantage, complexity, and reliability. A comparison between the three-phase a-c and the d-c mode of arc operation is made, evaluating the electrical component requirements for each arc operation. Special attention is given to high power rectification problems associated with d-c arc operation. Several rectification systems are evaluated for their applicability. Attention is focussed on the control requirements of the arc power. The control components are discussed, and their advantages and disadvantages in the space propulsion system are evaluated. (auth)

6018 EFFECT OF THRUSTOR CHARACTERISTICS ON ELECTRIC SPACECRAFT MISSIONS. William R. Mickelsen (Lewis Research Center, Cleveland). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-676, 22p, $1.00. (CONF-640801-10)

From 4th Electric Propulsion Conference, Philadelphia.

It is shown that when power conversion, power conditioning, and thrustors are included in mission analysis, the total effective specific mass of the electric propulsion system may be much higher than that of the electric powerplant alone, resulting in a significant loss of payload or an increase in trip time. A method of system analysis is presented that determines the effect of each subsystem on the propulsion system effective mass. Using this method, effective specific masses are estimated for a range of powerplant specific masses and for a number of missions. The results indicate that existing electric thrustors are primarily responsible for these large effective specific masses because of inability to operate with a variable specific impulse, requirements for power conditioning, thrustor mass, and thrustor inefficiency. (auth)

6019 HIGH SPECIFIC IMPULSE THERMO-IONIC ACCELERATION. Adriano C. Ducati, Erich Muehlberger, and G. Giannini (Giannini Scientific Corp., Santa Ana, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-668, 21p, $1.00. (CONF-640801-17)

From 4th Electric Propulsion Conference, Philadelphia.

The development of the high-specific-impulse plasma-jet system is summarized, with particular emphasis on improvements extending the life of the electrodes. (D.C.W.)

6020 ANALYSIS OF LOOSELY COUPLED TUBE SHEETS. J. E. McConnelee (General Electric Co., Cincinnati). 16p. (CONF-446-69)

From American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

An analysis of tube sheets in which only a transverse coupling exists between the plates is presented. Relations are obtained for the edge displacements and rotations in terms of the edge shears and moments. Expressions are also derived for calculating the tube sheet displacements and internal moments after the boundary forces are obtained. The results for a sample problem are included. (D.C.W.)

6021 ANNULAR MAGNETIC HALL CURRENT ACCELERATOR. Gordon L. Cann (Electro-Optical Systems, Inc., Pasadena, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-670, 60p, $1.00. (CONF-640801-20).

From 4th Electric Propulsion Conference, Philadelphia.

A plasma-jet engine was developed in which Hall currents are used to accelerate the gas. Some of the thrust comes from magnetic pumping effects. The operating characteristics and performance of three configurations were investigated. An engine using H_2 propellant was operated at specific impulses to 11000 sec and efficiencies to 70%. Operation was achieved with argon and nitrogen as well. Engines were operated successfully over a range of power from 1 to 200 kw. A model for the plasma-magnetic field interaction was developed. It was shown analytically and experimentally that the exhaust jet is magnetically confined by a combination of Hall-current and pinch forces. (D.C.W.)

Applications of Nuclear Explosions

6022 NUCLEAR DIGGING. Michael Friedlander. Scientist Citizen, 7: No. 1, 1-16(Nov. 1964).

A review of developmental work on nuclear excavating is presented. Aspects of nuclear explosions are discussed

including cost, blast effects, radioactivity, cratering, and biological risk. Discussions of present and future Plowshare projects are also included. (J.R.D.)

Facilities and Equipment

6023 (CEA-R-2520) STATION D'ESSAIS THERMIQUES DE GRAND QUEVILLY CIRCUIT DE SODIUM DE 5 MW AVEC GENERATEUR DE VAPEUR SURCHAUFFEE A 545°C. (The Grand Quevilly Thermal Test Station—The 5-Mw Sodium Circuit With a Generator of Superheated Steam at 545°C). Marcel G. Robin (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). July 1964. 50p. Dep.(mn).

A 5 Mw installation is described which is a reduced model of the heat exchange system of a sodium-cooled reactor. This plant, which is situated at Grand Quevilly (near Rouen), consists of: a primary sodium loop made up of a sodium re-heater running on heavy diesel oil, a mechanical pump, and an intermediate exchanger made up of clusters of tubes fitted with baffles; a NaK(56 per cent of K) secondary loop consisting mainly of a mechanical pump and a double-wall steam generator with forced circulation and complete vaporization; and a tertiary water loop consisting of the inside of the steam generator pipes, a pressure-reducing valve which cools down the super-heated fluid and acts as a turbine, a condenser, a charge-pump, and a supply pump for the boiler. The heat is given finally to a water-source flowing into the Seine. Two important points of the installation are the water treatment unit and the control and regulation system. The construction was finished on April 28th, 1964. (auth)

6024 (CEA-R-2523) POMPES ELECTROMAGNETIQUES ANNULAIRES—CONSTRUCTION ET ESSAIS—THEORIE ET CONFRONTATION AVEC L'EXPERIENCE. (Annular Electromagnetic Pumps—Construction and Testing—Theory and Comparison with Experimental Results). Etienne-P. Cambillard and Bernard-L. Schwab (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). July 1964. 76p. Dep.(mn).

This report consists of three sections. The first is concerned with the description of different pumps which have been constructed, tests, and results obtained. The second section presents a theoretical method for the determination of the coefficients, taking into account the break of the magnetic circuit. It is shown that the preliminary design calculations of the annular pumps can be made, neglecting the break of the magnetic circuit, by further assigning essential magnitudes (pressure, losses) with easily calculated coefficients. The third section of this report uses the theoretical bases exposed in the second section, and develops a new annular pump calculation method, which takes into account both the current out of balance and any type of winding. (auth)

6025 (CEA-R-2606) CALCUL DES BOBINAGES POUR LA PRODUCTION DE CHAMPS MAGNETIQUES TRES HOMOGENES. (Calculations for Coils for the Production of Very Homogeneous Fields). Henri Desportes (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). Oct. 1964. 49p. Dep.(mn).

A complete set of programs is described for the calculation, in the case of cylindrical systems, of the magnetic field components at any point, the lines of flux, the forces, the self and mutual inductances, as well as the design of compensated coils for the production of strong, highly homogeneous fields. These programs have been employed for the calculation of two magnets, which are described in detail. (auth)

6026 (GEAP-4728) RADIAL VANE STEAM SEPARATOR DEVELOPMENT. First Quarterly Report, June–September 1964. R. H. Moen (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Oct. 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT (04-3)-189. 48p. (EURAEC-1253). Dep.(mn); $2.00(cy), 1(mn) OTS.

A schedule for development of the radial-vane steam separator was worked up which shows the proposed analyses, tests, and expected results, and gives the purpose of the study and the anticipated dates. Studies in the Air–Water Test Facility of velocity distribution in the wall flow of the model separator have established that the flow is essentially as predicted. Tests of the model separator at reactor conditions indicated little effect of plenum deflectors on carry-over (but a small decrease in pressure drop on removal), lower separator pressure drop, lower carry-over, and a greater carryunder than previously reported. An annular outlet (replacing the former side outlet) to the model separator was constructed to improve the flow symmetry, new and improved nozzle plugs were built, and the steam sample system was improved. (auth)

6027 (RFP-449) INDIUM SEALS. R. O. Adams (Dow Chemical Co. Rocky Flats Div., Golden, Colo.). Dec. 2, 1964. Contract AT(29-1)-1106. 8p. Dep.; $0.50 (cy), 1(mn) OTS.

The feasibility of using indium seals for large vacuum bell jars has been investigated. It is shown that such seals can be made; however, use of this type seal for repetitive operations is not recommended. (auth)

6028 (TID-21379) A BIBLIOGRAPHY ON DYNAMIC SHAFT SEALS. William K. Stair (Tennessee. Univ., Knoxville. Engineering Experiment Station). May 1962. For Oak Ridge National Lab., Tenn. Contract [W-7405-eng-26], Subcontract No. 2118. 101p. (ME-5-62-3). Dep.(mn); $4.00(cy), 2(mn) OTS.

A total of 406 references, some in abstracted form, is presented which treat the theory of the sealing mechanism, provide experimental data useful for the design of a seal, or are relevant to the problem of dynamic sealing. The references were published through December 1961. A subject index is included. (D.L.C.)

6029 DESIGN OF HIGH FIELD ELECTROMAGNET. Shigeki Hayashi and Susumu Shimamoto. Denki Shikensho Iho, 28: 263-72(1964). (In Japanese)

It is shown that even in high fields an iron piece can increase the field strength since the specific permeability of iron is not unity above its saturation in principle. Field-up coefficient which contrasts with the demagnetizing coefficient is introduced with some calculated examples. The values of magnetic fields calculated by means of the field-up coefficient agree with experimental results. A method of designing high field electromagnets is given, separated into two parts, one for the inner part where the saturation takes place and the other for the outer part. (auth)

6030 PROCEEDINGS OF THE TWELFTH CONFERENCE ON REMOTE SYSTEMS TECHNOLOGY (FORMERLY CONFERENCE ON HOT LABORATORIES AND EQUIPMENT) HELD IN CONJUNCTION WITH AMERICAN NUCLEAR SOCIETY WINTER MEETING, SAN FRANCISCO, CALIFORNIA, NOVEMBER 30–DECEMBER 3, 1964. Malcolm Ferrier, ed. (American Nuclear Society, Hinsdale, Ill.). 1964. 417p. $10.00(American Nuclear Society, Hinsdale, Ill.). (CONF-654)

A total of 43 papers is presented which covered hot laboratories, remotely operated equipment, and other equipment developed for nuclear and other hostile environments. The papers are arranged into sections dealing with hot-cell facilities, manipulators and viewing, special equipment and operations, undersea remote technology, techniques used with alpha emitters, and technical notes. Separate abstracts were prepared for 36 of the papers. For abstracts of the other 7 papers, see NSA 18: 41595, 44057, 44106; and 19: 570, 2433, 2765, and 2858. (D.L.C.)

For abstracts of individual papers see: 5997, 6011, 6031, 6032, 6033, 6034, 6035, 6036, 6037, 6038, 6039, 6040, 6041, 6042, 6043, 6044, 6045, 6046, 6047, 6048, 6049, 6050, 6051, 6052, 6053, 6054, 6055, 6056, 6057, 6058, 6134, 6135, 6154, 6155, 6264, and 6283.

6031 A NINE-STATION ALPHA-GAMMA FACILITY. James H. Saling, Elmer C. Luck, and John E. Gates (Battelle Memorial Inst., Columbus, Ohio). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 3-8.

A new alpha-gamma facility was designed and constructed which will permit handling of highly radioactive materials under a protective atmosphere. The facility was designed to provide complete containment of the radioactive materials, will be used in studies of radioisotopes and irradiated nuclear fuels, and was constructed in space available in the Battelle Hot Cell Facility. (auth)

6032 DESIGN AND EQUIPMENT OF THE ALPHA-GAMMA HOT-CELL FACILITY AT THE KARLSRUHE NUCLEAR RESEARCH CENTER. G. Boehme and P. Gottlob (Nuclear Research Center, Karlsruhe, Ger.). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 9-13.

Five gastight hot cells are provided for examination of reactor experiments and irradiated fuel elements. The cells are equipped for handling alpha-gamma active material. This equipment has been designed to permit remote insertion and removal, as well as maintenance, disassembly, repair, and reassembly by remote control. The manipulators are of a novel design offering some advantages over conventional models. Remote viewing equipment consists of dry, high-density lead glass windows and special periscopes. The cells may be operated for some years under gastight and alpha-tight conditions without any personnel entering them. (auth)

6033 A NEW TYPE OF CHEMISTRY CELL FOR HIGH SPECIFIC ACTIVITY AT FONTENAY-AUX-ROSES. G. Lefort (Commissariat a l'Energie Atomique, Fontenay-aux-Roses, France) and R. Paquis. Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 15-24.

An alpha, beta, gamma cell is described which was recently built at Fontenay-aux-Roses. It will serve for the recovery of highly active irradiated fuel elements. The gamma shielding is 10 inches thick. The alpha cell is subdivided into three sections: two working cells measuring 165 inches by 50 inches by 45 inches and one interconnecting central cell measuring 78 inches by 39 inches by 41 inches. Altogether there are seven working places. The most important details of the cell construction and the auxiliary equipment are described. (auth)

6034 50-KILOCURIE GAMMA IRRADIATION FACILITY. R. M. Jefferson (Sandia Lab., Albuquerque, N. Mex.). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 25-9.

To supplement the reactor facilities presently in use for radiation effects studies, Sandia Laboratory has designed and constructed a Gamma Irradiation Facility which is described. The facility combines what was felt to be the desirable characteristics of other gamma facilities to provide a capability for a broad variety of envisioned experiments. The facility consists essentially of two hot cells above a pool. Through the use of self-contained handling equipment, sources may be readily introduced and removed from these cells. Provisions are included for visual, physical, and electrical access as well as control to provide the necessary safety. Several problems encountered in the operation of this facility are also discussed. (auth)

6035 CONCRETE HOT CELLS FOR DISMANTLING AND MACHINING AT THE ISPRA RESEARCH CENTER. P. Barthelemy, G. Bonnet, J. M. Junger, J. Cauwe, and R. Kiersy (European Atomic Energy Community, Ispra, Italy). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 31-8.

A description is given of concrete hot cells which are or will be soon in operation at the EURATOM Joint Research Center at Ispra (Italy). Discussed are only the three cells devoted to dismantling and machining, namely two gamma cells, one of which is associated with Ispra 1 Reactor and the other with the Orgel Critical Experiment Reactor, and one alpha-gamma cell which is located at the base of a U-line of cells in the hot metallurgical laboratory. The Ispra 1 cell is now used for dismantling loops or fuel elements; therefore it is equipped with a cutting machine and a Siersatom decanning machine. The critical reactor cell is now at the end of the design stage and will allow dismantling fuel elements by unscrewing, without decanning, fuel rods. The metallurgical cell will be in operation next December. (auth)

6036 THE U. S. NAVAL RESEARCH LABORATORY HIGH-LEVEL RADIATION LABORATORY. Henry E. Watson and Lendell E. Steele (Naval Research Lab., Washington, D. C.). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 45-53.

The High Level Radiation Laboratory was constructed to provide shielded facilities for the evaluation of the physical and mechanical properties of radioactive metals and alloys. The five in-line hot cells are equipped for metallographic preparation and examination, physical and mechanical testing, and machine-shop operations. The supporting areas include a radiochemistry laboratory, facilities for decontamination, isotope storage, liquid radioactive waste disposal, and miscellaneous supporting laboratories and shops. The special features of the laboratory include transfer ports, electrical patch panels, access openings, intercell transfer gates, isolation cubicles, a decontamination room, and an isotope storage area. The laboratory has been designed to provide maximum utilization of space; at the same time, it incorporates all features necessary for the safe handling and confinement of radioactive materials. (auth)

6037 THROUGH-THE-WALL MASTER-SLAVE MANIPULATOR WITH INDEXING FOR FORWARD AND BACKWARD MOVEMENT. Jean Vertut (Commissariat a l'Energie Atomique, Saclay, France). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 67-72.

This manipulator was designed for work in high activity cells of small dimensions. It incorporates an articulated arm which does not require any telescopic movement. Fitted with an indexing device for forward and backward movement, it can be used with small viewing ports. The manipulator penetrates the front wall of the cell and is of a design permitting very simple and rapid insertion and removal. A protective sleeve fabricated from a flexible (plastic) material provides a hermetic seal of the inner face. This protective sleeve can be replaced without changing the pressure conditions inside the cell. (auth)

6038 A COMPACT AND FLEXIBLE SERVOSYSTEM FOR MASTER-SLAVE ELECTRIC MANIPULATORS. L. Galbiati, C. Mancini, T. Raimondi, and F. Roncaglia (Comitato Nazionale per l'Energia Nucleare, Casaccia, Italy). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 73-87.

A description is given of a force-reflecting servosystem for 50-pound capacity electric master-slave manipulators, incorporating several improvements over the previously developed models. The new system, which uses separate power amplifiers, is more flexible, in that provision is made for electrically balancing the manipulator arms and for improving the system's "feel" characteristics by suitable feed-back force signals. The power amplifiers, which are of the switch type, are highly efficient, compact, and cooled by natural convection. These characteristics facilitate the installation of the amplifier on the slave station as required for a possible radio control. In order to reduce the number of leads in the cables, the system uses as position transducers two linear synchros, fed at the same frequency as the tachometer generators. The servo drive units are more compact, than previously, permitting a substantial reduction in the bulk of the manipulator. (auth)

6039 REMOTELY OPERATED SERVICE MODULE FOR MAINTENANCE OF ORBITING SYSTEMS. C. E. Vivian, W. H. Wilkins, and L. L. Haas (Lockheed Missiles and Space Co., Sunnyvale, Calif.). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 89-104.

A remotely operated, manipulator-equipped module for servicing, maintaining, and refurbishing of orbiting systems

has been designed, in concept. The primary philosophy of this device is to allow man to service and maintain the extremely expensive equipment he places in orbit, yet be able to operate in a shirtsleeve atmosphere with minimum hazard. This recoverable service module will operate in either an orbit-to-orbit or an earth-to-orbit configuration in its present concept and can be adapted to an earth-to-earth or earth-to-lunar surface mode of operation by replacing the rocket engines with wheels or treads. The command link to the module is in a digital form that can be accessed directly to an onboard computer which provides coordination to the manipulator arms. These coordinated data are compared to data concerned with the present position of the arms and, if a new position is required, provide a rate signal to the arm actuators that is a function of the positional error. Each manipulator arm is equipped with a black and white two-dimensional television monitor for observation of the hand at short range. In addition, a three-dimensional color television system is used for an over-all view of the work area and vicinity. Additional necessary data are telemetered to the operator, for redundancy, where they are displayed in digital form. (auth)

6040 A TAXONOMY FOR REMOTELY OPERATED SYSTEMS. John W. Clark (Battelle Memorial Inst., Columbus, Ohio). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 105-16.

A taxonomic classification scheme for hostile-environment equipment is proposed, applicable to any hostile, hazardous, or inaccessible region in which manual work must be performed. The six functions which must be performed in the generalized hostile-environment situation are identified. Five distinct methodologies are proposed into which to classify all hostile-environment equipment which has been built. Since these classifications are independent, a 30-element matrix can be prepared showing how each function is accomplished in each methodology. The classification scheme is useful for selecting equipment to perform specific tasks in a hostile environment, and for planning basic research in hostile-environment operations. (auth)

6041 MANIPULATOR SYSTEMS DEVELOPMENT AT ANL. Ray Goertz (Argonne National Lab., Ill.). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 117-36.

A review is presented of some of the significant developments of general-purpose manipulators and closely associated devices carried out at the Argonne National Laboratory over the past decade and a half. A few unilateral manipulators were developed which were operable with switches and had no force-reflection. Most of the work, however, has been devoted to mechanically connected and electrically connected master-slave manipulators which have force feedback in all of the seven basic motions. The first mechanical master-slave manipulator was developed in 1949 and the first electric master-slave manipulator was developed in 1954. The Mechanical Master-Slave Manipulator Model M8 is the most widely used and it is the last mechanical master-slave manipulator to be completely developed at ANL. The Electric Master-Slave Manipulator Model E3 is the latest of its type. Four such manipulators have been working and giving good service since early 1960. Although considerable progress has been made in the development of manipulators, the rate of performing typical hot laboratory work with a high-performance electric or mechanical master-slave manipulator is only about $\frac{1}{8}$ the speed of performing the same operation directly with the hands. Clearly, much is yet to be done, on advanced future manipulator systems. (auth)

6042 PILOT SCALE ALPHA-GAMMA FACILITY FOR REPROCESSING OF SPENT REACTOR CERAMIC FUELS BY VOLATILIZATION OF FLUORIDES. R. Heremans (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.), J. Schmets, J. Broothaerts, M. Haegeman, R. De Beukelaer, A. Buyle, and H. Leponge. Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 137-48.

A pilot scale α-γ facility is being constructed to study the possibilities of remote chemical processing of spent reactor ceramic fuels by fluidization techniques. The decontamination of the spent reactor ceramic fuels is based on oxidation-hydrofluorination-fluorination steps. The process apparatus is composed of a mechanical decanner for irradiated fuel elements, a fluidized bed reactor with gas preheater and decantation chamber for the chemical operations, a cyclone for the recuperation of solid fission products, and a UF_6 condensation and recovery system. For various reasons these process apparatus are located in two different α boxes. Current introductions and removals into the boxes are performed by means of tight casks. The α tightness during these operations is ensured by means of French triple-effect joints. These casks can also be γ shielded and are transportable in standard lead containers. The total β-γ activity which can be safely handled is about 200 curies 1 Mev. Inside the α_1 box, different accessories were grouped together on a mobile chassis to form a unit. For instance, the gas preheater, fluidization column, and decantation chamber form the chemical transformation unit. These units are constructed in such a way that they can be easily remotely dismantled and repaired inside the α_1 box. Tongs mounted on ball manipulators, a General Mills model 150 manipulator, and a 250 kg movable crane, complete the remote manipulation systems. (D.L.C.)

6043 ADAC-DESIGN OF ALPHA-BETA-GAMMA CELLS WITH ALPHA BACK CELLS AND TRANSFER FACILITIES. R. Mas (Commissariat a l'Energie Atomique, Cadarache, France), A. Tarbe De Saint-Hardouin, and P. Lecouvreur. Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 149-57.

The hot cells of the Shop for Cutting Fuel Assemblies for the fast-neutron reactor RAPSODIE (ADAC) are designed as a sealed unit with the shielded cells in front and adjacent to the back cells in which a man wearing a frogman suit can work. The following equipment was designed to meet the requirements of these hot cells: remote-handling facilities for transferring the machinery elements from the front to the back cells; sealing devices; and visual, control, and communications facilities. (auth)

6044 ADAC-OPERATION OF A FUEL-DISMANTLING LINE IN A CELL MOCKUP. R. Mas (Commissariat a l'Energie Atomique, Cadarache, France), V. Gerard, and A. Tarbe De Saint-Hardouin. Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 159-65.

Prototype machinery for dismantling the fuel assemblies of the RAPSODIE fast-neutron reactor in the ADAC cells at Cadarache was investigated in a full-size cell mockup. These operations included all the handling, visual control, and test equipment to be used in the ultimate cells. As soon as these prototypes were received from the manufacturer, they were used with the fuel assembly prototypes to simulate dismantling and transfer operations. (auth)

6045 A NEW TYPE OF AIR-TIGHT TONG FOR MASTER-SLAVE MANIPULATORS. G. Lefort (CEA, Fontenay-aux-Roses, France), J. P. Cazalis, and J. Rouillard. Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 167-72.

A new air-tight booting connection system is described which can be used with master-slave manipulators. This system forms part of the protective sleeve. Four locking mechanisms based on ball catches are used. The upper part of the system is attached to the wrist of the slave arm while the lower part (transmission piece) is locked to the cable. A diaphragm is located between these two parts, to provide an air tight seal. This diaphragm is not subjected to mechanical stresses. The tong can easily be attached to this system. The various advantages of this system are critically reviewed. (auth)

6046 OPERATIONAL EXPERIENCE OF THE BR2 HOT CELLS. J. P. Valentin (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 183-91.

The hot cells of the Materials and Engineering Test Reactor BR2 were designed for the dismantling of rigs irradiated in the reactor. They were built at a time when the experi-

ments to be irradiated were still unknown. The 60,000 curies, 2.75 Mev, hot cells have been in operation since the beginning of 1963. The first equipment was designed to accommodate many different rigs and emphasis was laid on the simplicity and flexibility of the facility. The experience gained in the dismantling of different types of rigs showed that the basic design was correct. It was found necessary, however, to extend and refine the capabilities of the in-cell machines in order to accomplish the operations with the accuracy required. Moreover, the lack of high activity analytical cells led to a more varied use of the existing facility. The original evaluation of the operational philosophy and of the hazards has been modified and adapted to the problems actually encountered. (auth)

6047 AN INERT ATMOSPHERE GLOVEBOXED EXTRUSION PRESS. G. Burton, Jr., and A. B. Shuck (Argonne National Lab., Ill.). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 217-27.

A 600-ton (545-tonne) capacity, automatic cycle, direct-indirect extrusion press was installed at Argonne National Laboratory for fabricating plutonium alloys and other reactive fuel materials. The press and auxiliary equipment are enclosed in a 2600-ft^3 (74-m^3) trisectional glovebox train that is filled with a recirculated and purified helium atmosphere. The press and auxiliary equipment incorporate special design features which facilitate installation and operation in the glovebox. A stretcher-straightener detwister having a 25-ton (23-tonne) pull and a 1800 pound-foot (248.9 kilogram-meter) twisting force is located adjacent to and on the centerline of the press. (auth)

6048 PNEUMATIC TRANSFER FLASH IRRADIATION DEVICE. Jean Vertut and Robert Seran (Commissariat a l'Energie Atomique, Saclay, France). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 229-38.

Irradiation devices using easily interchangeable sources and allowing "flash" irradiations by fast transfer are described. The sources, put in a spherical source-holder, are propelled by pneumatic pulses through transfer pipes to either of two end positions. The storage position and irradiation position are located in the lower parts of the circuit; thus, the source cannot move by itself from these locations. This system has been applied to (a) dosimeter badge calibration, (b) irradiation of animals, and (c) electronic device calibration. Sources in the activity range 0.5 to 300 Curies are used. An irradiation facility designed for agronomic studies and including 6 sources of 2,000 Curies is being built. (auth)

6049 UNDERSEA REMOTE TECHNOLOGY. Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 279-82.

Brief summaries are presented of six talks on the development of undersea remote technology. Among the topics discussed are nuclear undersea applications, underwater manipulators, oceanographic research and engineering, exploration, the ALUMINAUT submarine, and the Navy's Deep Submergence Systems project. (D.L.C.)

6050 THE ANL ALPHA-GAMMA METALLURGY HOT CELL— ITS DESIGN PHILOSOPHY AND COMPONENTS. R. C. Goertz, K. R. Ferguson, J. F. Lindberg, D. P. Mingesz, R. A. Blesch, C. W. Potts, J. H. Grimson, G. A. Forster, F. L. Brown, and J. L. Armstrong (Argonne National Lab., Ill.). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 285-306.

A kilocurie alpha-gamma hot cell complex designed for carrying out metallurgical research on irradiated plutonium and other toxic materials was placed in preliminary operation early in 1964. The hot cell complex has a main working area (11 × 32 ft) capable of containing a high-purity nitrogen atmosphere, and several integral, shielded service areas (with only an air atmosphere) to provide for storage of contaminated equipment, remote repair, glove repair, transfers, and so forth. The facility is designed so that, when fully equipped, it can be operated for extended periods of time without personnel entry into the area which becomes contaminated under normal operation. However, to achieve the intended degree of remote operation, the unilateral electric manipulators now installed must be replaced with electric master-slave manipulators mounted on vehicles and overhead support systems. (auth)

6051 STARTUP OF THE ANL ALPHA-GAMMA METALLURGY HOT CELL. F. L. Brown and B. J. Koprowski (Argonne National Lab., Ill.). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 307-13.

A startup period has recently been completed in the operation of the Argonne National Laboratory Alpha-Gamma Metallurgy Hot Cell. Constructed for postirradiation studies on fuel materials containing plutonium, the cell structure embraces a large working area that contains a nitrogen atmosphere for the experimental work, and a compartmented service area with air atmosphere for storage and repair of equipment and waste disposal. The nitrogen-atmosphere working area is designed for continuous operation by remote control of all procedures from installation of test equipment to the final cleanup. This is done without benefit of personnel entry into the area at any time. During startup, postirradiation studies were made on samples not containing plutonium so that cell entries could be made to effect minor equipment adjustments without the attendant difficulties of alpha contamination. Limitations of cell components were revealed and improvements were made wherever possible. Operation of the service area for introduction of equipment and specimens and for the disposal of contaminated wastes was investigated in startup operations on the alpha-free materials. Recommendations were then made for improvement of operating equipment and cell components. (auth)

6052 A SYSTEM FOR A NITROGEN ATMOSPHERE IN AN ALPHA-GAMMA HOT CELL. B. J. Koprowski, W. H. Livernash, and F. L. Brown (Argonne National Lab., Ill.). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 315-22.

Inert gas atmosphere systems developed and used successfully in gloveboxes are now being applied to large shielded facilities. One of these facilities, the Alpha-Gamma Metallurgy Hot Cell, constructed as a part of the Fuels Technology Center at Argonne National Laboratory has been provided with a nitrogen atmosphere. The hot cell, designed and constructed to enable studies to be made on irradiated ceramic and metal fuel materials containing plutonium, consists of two distinct areas: (1) a Main Operating Area of approximately 107.5 cubic meters (3,800 cubic feet) that contains a nitrogen atmosphere and (2) an auxiliary area for maintenance, repair and storage that contains an air atmosphere. The system employed is a once-through system whereby nitrogen gas is supplied to the cell from a liquid nitrogen source and then, after adequate filtration, is discharged to the atmosphere. Maximum concentrations of 0.5% oxygen and 1% moisture were set as the design goals. Construction of the facility was completed in March, 1963. During the following shakedown period, tests indicated a total leak rate of only 18 cc/min (6.35×10^{-4} cfm) of air. After operation of the cell at various flow rates, an optimum flow rate of 1.4 l/sec (3 cfm) nitrogen was established. This flow rate has consistently produced an atmosphere having impurity levels of 500 to 700 ppm oxygen and 400 to 600 ppm moisture. (auth)

6053 ACCESSORIES DEVELOPED FOR FIBERGLAS-REINFORCED PLASTIC GLOVEBOXES IN THE RESEARCH HOT LABORATORY. J. P. Hughes and F. J. Schmitz (Argonne National Lab., Ill.). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 323-8.

As a part of a continuing program, a number of accessories have been developed for the Argonne-designed fiberglass-reinforced plastic glove boxes. Accessories described include housing for a spectrophotometer and for an analytical balance, an "in-box" monitor for measuring high levels of alpha activity, a check valve for vacuum lines leading into the boxes, an acid-scrubber for handling fumes produced during chemical operations, entrance and transfer ports, waste disposal ports and waste container supports, bulkhead fittings for introduction of instrument lines, and

box doors, shelves, etc. Techniques used in cutting holes into a contaminated box are also described. (auth)

6054 EQUIPMENT ADVANCES IN THE TRANS-CURIUM ELEMENT RADIOCHEMISTRY FACILITY. M. S. Coops, V. E. Scribner, and C. L. Hanson (Univ. of California, Livermore). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 355-60.

The Livermore neutron cave facility has been modified to accept extended-reach master-slave manipulators. Two additional process boxes, that are fully interchangeable with the original enclosure, have been constructed to accommodate specialized equipment necessary in remotely performing trans-curium element chemistry. Some of the features in these enclosures are: High-geometry fast-neutron detectors for the determination of spontaneous fission content of process solutions, electromechanical devices to count and collect a predetermined number of drops of ion-exchange eluate per tube, a built-in console-operated chemical process system, and an ultramicro remote pipetting system for the radioanalysis of very active alpha solutions. (auth)

6055 VERSATILE UTILITY TOOLS FOR HOT-CELL OPERATION. D. W. Huszagh (Brookhaven National Lab., Upton, N. Y.). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 367-72.

The important features of four general purpose utility tools for hot-cell work are described. All of these "home made" devices fit in the gap between the available commercial machines, and the simple jigs and fixtures customarily devised by hot cell users. An auxiliary hoist for direct attachment and complementary use with bridge crane type electric manipulators employs an assemblage of stock commercial components. A positive locking, articulating electric grapple substantially increases the versatility of a cable hoist for remote pick up and load release, especially in handling irregular objects. A large, self-standing scanning mirror employs a very simple drive system featuring commercial valve and damper actuators with their versatile linkages. A rugged but simple remote-controlled boom crane, which stands in a cell corner, is ideal for handling portable shielding and other weighty objects. (auth)

6056 COMPACT CAPSULE OPENER FOR IN-CELL CONTAINMENT BOXES. W. C. Mohr (Argonne National Lab., Ill.). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 373-4.

A 7-lb small capsule opener is designed to be handled and operated by Model 8 master-slave manipulators. The opener includes a motor-powered capsule chuck and milling saw cutter. The chuck and cutter can be positioned relative to each other. (D.L.C.)

6057 REMOTE MOTOR-CONTROLLED CENTRIFUGE FOR HOT LAB. J. P. Hughes, G. A. Mack, and F. J. Schmitz (Argonne National Lab., Ill.). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 375-6.

A control unit was developed for regulating the speed of a centrifuge operating in a glove box. The control unit uses a small motor coupled to the variac which controls the voltage applied to the centrifuge. The small motor is operated by means of foot-operated toggle switches. (D.L.C.)

6058 PREPARATION OF GRAM AMOUNTS OF AMERICIUM FOR ENCAPSULATION. J. P. Hughes, F. J. Schmitz, and C. A. A. Bloomquist (Argonne National Lab., Ill.). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 391-3.

A glove box apparatus was devised for carrying out chemical separations on americium. The box was a double-sided glove box divided into a hot side for chemical operations and a cool side for weighing the purified americium in containers, and sheet lead shielding was fitted around the box. Other precautions taken to reduce the gamma hazard are described, such as local shielding within the box. The individual who did most of the chemical separations received a total hand exposure of 20 R, below the maximum permissible hand exposure for a 13-week period. (D.L.C.)

6059 CRYOSTAT FOR MAINTAINING SAMPLES AT LOW TEMPERATURE DURING THEIR IRRADIATION IN THE REACTOR. G. Glanz, N. Dutescu, and A. Georgescu (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 137-44(1964).

A cooling assembly with liquid nitrogen, useful for maintaining various materials at low temperature during their irradiation, is described. Details are presented on the cryostat itself, based on the principle of nitrogen draining through the bottom of the sample vessel, which prevents increase of the liquid oxygen concentration in it. An electronic control system of the value at the exit of the sample vessel permitted reduction of cooling-agent consumption in comparison with that in other cryostats of this type. The initial consumption was 15 l for cooling of the ducts. During operation of the reactor at 2 Mw the consumption reached 10 l/hr when no samples were introduced. The consumption increased upon introduction of 5 cc samples according to the heat generated during irradiation. (auth)

6060 MULTIPLE ROTOR MAGNETIC SUSPENSION SYSTEM. J. W. Beams (Univ. of Virginia, Charlottesville). Rev. Sci. Instr., 36: 95(Jan. 1965).

A technique is described by which rotors can be magnetically suspended, one above another. A three-rotor configuration is considered in detail. (D.C.W.)

6061 HARD X-RADIATION COMPONENT OF PULSED X-RAY TUBE. L. N. Khudyakova, E. K. Gutnikova, and L. V. Tarasova. Zh. Tekhn. Fiz., 34: 2044-7(Nov. 1964). (In Russian)

An estimation of the energy of the harder part of the radiation (330 kev to 3 Mev) of a pulsed 250-kv x-ray tube with a reversed cathode was carried out. The energy was determined by absorption in lead filters 2 to 8 mm thick and by measurement of the track lengths of recoil electrons in thick layered nuclear emulsions using calibrated ^{137}Cs and ^{60}Co gamma sources. (M.J.T.)

6062 ELIMINATION OF GASEOUS SURFACE CONTAMINATION. Don Lee (Barnebey-Cheney, Columbus, Ohio). 11p. (CONF-555-10)

From International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964.

Vaporous contaminants and their removal are discussed, and case histories are given. Titanium welding, for example, is improved in spaces where halogen vapors are removed by activated charcoal filtration. Corrosion of delicate electrical contacts may be caused by vaporous contaminants in concentrations so small that their removal, even their detection, is not feasible by any means other than activated charcoal. Gaseous contaminants that impede instrument operation by monomolecular deposition may usually be removed with activated charcoal air purification. Various types of activated charcoal equipment used for air purification in spaces where sensitive products are either fabricated or employed are described. (P.C.H.)

6063 IMPROVEMENTS IN APPARATUS FOR OBSERVING OBJECTS DISPOSED IN FLUID-TIGHT CHAMBERS. Jean Marie Chevallier and Pierre Rousseau (to Commissariat à l'Energie Atomique). British Patent 971,141. Sept. 30, 1964. Priority date Feb. 2, 1962, France.

An apparatus is described for observing objects heated in an evacuated chamber inside a glove box. A microscope is mounted outside the glove box but with its objective passing into the box through a flexible seal, the arrangement being such that the microscope may be manipulated entirely from outside the glove box. A source of illumination adapted to coact with an appropriate Nicol prism or polarizer outside the glove box is provided. The chamber containing the specimen is sealed at both ends, one end having a quartz window, and connected to an ultra-high vacuum pump. Means for heating and regulating the temperature of the chamber are provided. The apparatus is suitable for work with highly oxidizable or radioactive materials. (A.G.W.)

6064 RADIOGRAPHIC APPARATUS. Kenneth MacGregor Swanson (to United Kingdom Atomic Energy Authority). British Patent 971,414. Sept. 30, 1964. Filed June 4, 1962.

The apparatus described is applicable to the radiographing of a radioactive specimen in a shielded cell. An image of the specimen is projected on to a screen by x or γ radiation. Two discs of radiation-arresting material are interposed between the specimen and the screen. Each disc has radiation-transparent slits extending radially of the axis and is mounted for rotation about an axis aligned with the radiation source. The rotary axes of the two discs are coplanar but not collinear. The effect of the rotary wheels is to create a virtual point source of radiation. Mountings for the rotary members are adjustable to enable variation of the convergency of the rotary axes. (A.G.W.)

6065 MEANS FOR TRANSMITTING TORQUE THROUGH A GAS-AND-PRESSURE-TIGHT SEAL. (to Brown Boveri/Krupp Reaktorbau GmbH). British Patent 971,980. Oct. 7, 1964. Priority May 23, 1962, Germany.

Means are described for transmitting torque between one shaft located inside a sealed chamber and another shaft outside the chamber through an interposed separating element. The separating element is supported in a universal mount and connected by an elastically deformable sealing element to the walls of the chamber. The elastically deformable sealing element may be a springy resilient metal member or a membrane. Several possible designs of the separating element are described. (A.G.W.)

Heat Transfer and Fluid Flow

Refer also to abstract 6174.

6066 (AD-422146) TRANSIENT HEAT TRANSFER FOR STEADY SLUG FLOW OVER A FLAT PLATE WITH UNIFORM EXPONENTIAL HEAT GENERATION. SECTION I. H. A. Johnson and P. L. Chambre. THEORETICAL ANALYSIS OF THE TRANSIENT HEAT TRANSFER INTO A FLUID FLOWING OVER A FLAT PLATE CONTAINING INTERNAL HEAT SOURCES. SECTION II. Paul L. Chambre (California. Univ., Berkeley). Aug. 1963. Contract NONR-222(95). 55p. $5.60(OTS).

An analytic conduction solution is presented for the transient local and mean surface temperature of a flat plate heated by a uniform exponential heat source and cooled on both surfaces by a fluid in slug flow. The effect of thermal capacity of the plate is included but the internal resistance and conduction along the length is neglected. Numerical results are presented in tables and charts in terms of dimensionless arguments and a comparison is made with a sample of experimental data. Since the solution is in closed form and numerically evaluated, it should be of value as a reference for testing approximate methods of analysis. That the latter will be necessary is illustrated by the comparison with experiment in which the effective heat transfer coefficient for this solution underestimates the experimental values by factors of 2 to 3. (auth)

6067 (BAW-3238-4) NON-UNIFORM HEAT GENERATION EXPERIMENTAL PROGRAM. Quarterly Progress Report No. 4, April–June 1964. (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(30-1)-3238. 16p. (EURAEC-1143). Dep.(mn); $1.00(cy), 1(mn) OTS.

Experimental and analytical investigations are being conducted to determine the effects of irregular heat flow through reactor channels on the operating conditions that cause burnout (departure from nucleate boiling). Tubular specimens having four axial power shapes and annular specimens having five power shapes will be used, and an effort to correlate the experimental data with empirical and analytical models will be made. Time was spent designing, fabricating, and installing test sections; and obtaining data from the uniformly heated test section. Data were obtained using thermocouples for critical heat flux detection. (auth)

6068 (CEA-R-2469) ETUDE EXPERIMENTALE DU TRANSFERT DE CHALEUR ET DES PERTES DE CHARGES DES GAINES A AILETTES HELICOIDALES EN CHEVRON. (Experimental Study of Heat Transfer and Pressure Drops for Cans with Spiral Herring-Bone Fins). Jacques Pelce, Serge Francois, Oscar Houseaux, and Bernard Serge (France. Commissariat à l'Énergie Atomique. Centre d'Etudes Nucléaires, Saclay). Aug. 1964. 100p. Dep.(mn).

Cans fitted with herring-bone fins are used for cooling uranium in certain nuclear reactors. By herring-bone is meant a staggered arrangement of the fins which have a plane of symmetry parallel to the general direction of liquid flow. The main geometrical parameters are then: the number of fins, the number of herring-bones, the angle of inclination of the fins with respect to the can axis, the dimensions of the fins, the can diameter, and the channel diameter. The tests are of three types: full size tests, in conditions approaching those in the reactor (constant flux, CO_2 under pressure); full size tests but with a constant wall temperature, much easier to set up, and intended to distinguish rapidly between the merits of the various types of can; large-scale tests with air at atmospheric pressure for studying the phenomena in more detail. For each can tried out there is a corresponding pressure drop coefficient, a mean thermal exchange coefficient $\overline{Mo}$, and a minimum exchange coefficient Mo_{min} and Mo are related by the expression $Mo_{min} = Mo \times f_c \times f$, where f_c and f are respectively circumferential and longitudinal singularity factor determined from a statistical study of all the temperatures measured for each can. The results are presented in about thirty tables and figures, the most noteworthy results being summarized in the conclusion. (auth)

6069 (EURAEC-1084) HEAT TRANSFER CRISIS IN STEAM–WATER MIXTURES—EXPERIMENTAL DATA IN ROUND TUBES AND VERTICAL UPFLOW OBTAINED DURING THE CAN-2 PROGRAM. Topical Report No. 11. S. Bertoletti, G. P. Gaspari, C. Lombardi, G. Soldaini, and R. Zavattarelli (Centro Informazioni Studi Esperienze, Milan). June 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 060-61-7-RDI. 67p. (CISE-R-90). Dep.(mn); $3.00 (cy), 2(mn) OTS.

Tables are presented giving all the experimental data which were obtained with the CISE test plant No. 1 during the CAN-2 program. The range of conditions explored are: uniform axial power distribution, standard conditions at inlet and outlet; uniform axial power distribution, nonstandard conditions at inlet or outlet; and nonuniform axial power distribution, standard conditions at inlet and outlet. (D.L.C.)

6070 (EURAEC-1104) INVESTIGATION INTO THE CRITICAL BURNOUT WITH BOILING WATER. Report No. 09.02.03. Quarterly Report No. 11, April 1–June 30, 1964. H. H. Agena (Maschinenfabrik Augsburg-Nürnberg A. G., Nuremberg). July 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract 057-61-RDD. 14p. Dep.(mn); $1.00 (cy), 1(mn) OTS.

A bypass conduit to the steam separator was built into the circuit for use during repair of the damaged gasket on the steam separator lid. Critical burnout measurements at an internally cooled tube of 5 mm inner dia and a heated length of 178 mm at pressures between 92 and 116 bars were initiated. The measurements were not evaluated. When testing the second burnout detector, technical switching difficulties were encountered which delayed the application of the device. (auth)

6071 (KAPL-3067) ISOTHERMAL ASYMPTOTIC GROWTH AND COLLAPSE OF VAPOR BUBBLES ON A BOILING SURFACE. H. H. Rubin (Knolls Atomic Power Lab., Schenectady, N. Y.). Aug. 1964. Contract W-31-109-eng-52. 15p. Dep.(mn); $1.00(cy), 1(mn) OTS.

In a study using the qualitative results of the Dougherty-Rubin analysis, the bubble growth and collapse were assumed to be governed by heat conduction from a superheated liquid layer of finite thickness to a hemispherical vapor bubble at saturation temperature. Relationships were obtained for the vapor-bubble lifetime, observed asymmetry ratio, maximum size, and growth-collapse trajectory. The growth-collapse trajectory thus obtained agreed well with the Dougherty-Rubin result. The predicted bubble lifetimes and maximum sizes were compared with the experimental measurements made by F. Gunther. (D.L.C.)

6072 (KR-73) DEVELOPMENT AND APPLICATION OF AN INSTRUMENT FOR DIGITAL MEASUREMENT AND ANALYSIS OF VOID USING AN AC IMPEDANCE PROBE. I. Bencze and I. Oerbeck (Norway. Institutt for Atomenergi, Kjeller). Sept. 1964. 44p. Dep.(mn).

A new type of a-c impedance instrument is described, suitable for local void measurements and flow pattern analysis. Experimental results show an error in local void measurements of 2.05% (standard deviation) for the range of velocities: $v_g = 0.6 - 2.0$ m/sec, and variable void between: $\alpha = 0.1 - 0.5$. One example of flow pattern shows good conformity with photograph. The method is being further developed by improvements of the measuring technique and by applying suitable data processing equipment. (auth)

6073 (NYO-3114-3) TWO-PHASE FLOW AND BOILING HEAT TRANSFER. Quarterly Progress Report, April–June 1964. G. B. Wallis, D. A. Steen, and J. M. Turner (Dartmouth Coll., Hanover, N. H. Thayer School of Engineering). June 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(30-1)-3114-1. 19p. (EURAEC-1145). Dep.(mn); $1.00(cy), 1(mn) OTS.

Void fraction data for vertical annular two-phase flow are reported. Results at three different pressures correlate satisfactorily. Changes in tube diameter and fluid properties produce deviations which are not yet fully understood. (auth)

6074 (TID-21331) FORCED-CONVECTION VAPORIZATION OF POTASSIUM IN A SINGLE TUBE. P. J. Berenson (Garrett Corp. AiResearch Mfg. Div., Los Angeles). Nov. 1964. Contract AF33(615)-1551. 150p. (APL-TDR-64-115). Dep.(mn); $4.00(cy), 3(mn) OTS.

A description is given of work undertaken to resolve uncertainties in the forced-convection vaporization characteristics of potassium that affect the SNAP-50/SPUR boiler design. A review is presented of liquid-metal and forced-convection vaporization heat transfer. The test program and single-tube boiler developed to measure liquid and high-vapor-quality potassium heat transfer coefficients are described. Finally, the data processing procedure and results of the test program are described and discussed. The major conclusions were that, with a twisted-tape insert in the tube, the quality beyond which the heat transfer coefficient decreases very rapidly, due to the formation of dry spots, is 80 to 90 percent, and the heat transfer coefficient beyond this quality remains an order of magnitude greater than the corresponding dry-vapor coefficient. (auth)

6075 (WAPD-TM-465) HOT-1—A TWO-DIMENSIONAL STEADY-STATE HEAT CONDUCTOR PROGRAM FOR THE PHILCO-2000. R. B. Smith and J. Spanier (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). July 1964. Contract AT(11-1)-Gen-14. 64p. Dep.(mn); $3.00(cy), 2(mn) OTS.

HOT-1 is a digital computer program to solve two-dimensional plane and axially symmetric steady-state heat conduction problems with diagonal boundaries and interfaces. Mesh spacing (at most 5000 points) is completely variable. As many as 99 regions are permitted in order to describe spatial variations in material properties, heat generation rates, and boundary conditions. (auth)

6076 THE DETERMINATION OF FORCED-CONVECTION SURFACE-BOILING HEAT TRANSFER. A. E. Bergles and W. M. Rohsenow. J. Heat Transfer, 86: 365-72(Aug. 1964).

Parameters affecting surface boiling are reviewed. Data are presented on incipient boiling, subcooling, fully developed boiling, and pool boiling. Four different boiling curve procedures were examined in order to estimate heat transfer with forced convection. It was concluded that at low wall superheat conditions, conventional forced convection correlations can be used. An analysis was made predicting incipient boiling for surfaces with commercial finishes. The expressions obtained could be used up to 2000 psia. (M.C.G.)

6077 INFLUENCE OF INTERNAL THERMAL RADIATION ON HEAT TRANSFER IN UO_2 FUEL ELEMENTS. R. Viskanta (Purdue Univ., Lafayette, Ind. and Argonne National Lab., Ill.). Nucl. Sci. Eng., 21: 13-19(Jan. 1965).

Heat transfer in flat-plate UO_2 fuel elements was studied theoretically. Particular attention was focused on internal-radiation heat transfer. Local radiant-heat fluxes were calculated, and the relative importance of radiation compared to conduction was established. The results show that even at elevated temperatures single-crystal UO_2 is transparent enough, and internal radiation contributes significantly to high-temperature heat transfer. The presence of scattering at the grain boundaries in polycrystalline UO_2 increases the extinction coefficient considerably. Because of this, radiant heat transfer was found to be unimportant compared to conduction. (auth)

6078 HEAT-TRANSFER TO LIQUID METALS FLOWING TURBULENTLY BETWEEN PARALLEL PLATES. O. E. Dwyer (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 21: 79-89(Jan. 1965). (BNL-7560)

An analytical study was made of the general problem of heat transfer to liquid metals flowing between parallel plates. All the results are for the conditions of uniform heat fluxes and fully-established temperature and velocity profiles. Both unilateral and bilateral heat-transfer situations were considered. In the former, three different methods of determining the velocity profiles were compared; and for each of these, three different types of profile curves for the eddy diffusivity of momentum, ϵ_M, were compared. The three different methods of determining the velocity profiles showed remarkably good agreement. In the case of bilateral heat transfer, the fraction of total heat transfer to the fluid from any one plate, ξ, was varied from zero to unity. It was found that the heat-transfer coefficient for any one plate is a sensitive function of ξ for that plate. Above $\xi = 0.31$, the coefficients are positive; below it, they are negative. At $\xi = 0.31$, the coefficient is infinite, because at this condition the difference between wall and bulk temperatures is zero. As ξ approaches 0.50, from either above or below, the shape of the ϵ_M profile in the vicinity of the center of the channel has less and less effect on the heat-transfer coefficient. When $\xi = 0.50$, the effect is negligible for all practical purposes. There are no adequate experimental data available with which to test the calculated Nusselt numbers, but indications are that the recommended relations are reasonably correct. (auth)

6079 BILATERAL HEAT TRANSFER TO LIQUID METALS FLOWING TURBULENTLY THROUGH ANNULI. O. E. Dwyer and P. S. Tu (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 21: 90-105(Jan. 1965). (BNL-8088)

The results of an analytical study of bilateral heat transfer to liquid metals flowing turbulently through annuli are reported. The study was based on the assumptions of uniform, though not necessarily equal, heat fluxes from the walls; fully-established temperature and velocity profiles; no effect of transverse temperature variations on the physical properties of the liquid metal. The fraction, ξ, of the total heat delivered to the flowing stream which comes from the inner wall was varied from zero to unity. Also two special situations were treated: equal heat fluxes from both walls, and uniform but unequal heat fluxes at the walls,

with equal wall temperatures at a given axial position along the channel. The results are presented in the form of Nusselt numbers for r_2/r_1 values from 1 to 7, Peclet numbers for 10^2 to 10^4, and ξ values from 0 to 1. The coefficient for the heat transferred from the inner wall goes to infinity at a certain value of ξ, which depends only on the ratio r_2/r_1. The same thing occurs for the coefficient for the outer walls, except at different values of ξ. The observation was made that at $\overline{\Psi}$ Pe = 6700, the Nusselt numbers for the following situations are all equal to about 35: flow in a pipe; flow between parallel plates with equal heat fluxes from both plates; flow in any annulus with equal heat fluxes from the walls, with reference to the heat transferred from the outer wall; flow in any annulus with a uniform heat flux from each wall and having equal wall temperatures at a given axial position, with reference to the heat transferred from the outer wall. (auth)

6080 BOLTZMANN EQUATION APPLIED TO A PROBLEM OF TWO-PHASE FLOW. F. E. C. Culick (California Inst. of Tech., Pasadena). Phys. Fluids, 7: 1898-1904(Dec. 1964).

A limiting case of the interaction between particles in a viscous fluid is described by a linear form of Boltzmann's equation. The distribution function, $f(v)$, is found for small particles falling under the action of gravity and viscous drag and colliding with large particles. Several approximate procedures for computing $f(v)$ and the connection with flows of gases containing solid particles are examined. (auth)

6081 LAMINAR TWO-PHASE BOUNDARY LAYERS IN NATURAL CONVECTION FILM BOILING OF SUBCOOLED LIQUIDS. Traugott H. K. Frederking (Univ. of California, Los Angeles) and Joram Hopenfeld. Z. Angew. Math. Phys., 15: 388-99(July 25, 1964).

The thermodynamic behavior of a liquid-cooled reactor was studied using an interpolation formula derived from asymptotic solutions for subcooling. The problem of two-phase boundary layers in natural-convection film boiling on a vertical heat-emitting plate was extended to subcooled liquids. The analytical results were in fair agreement with data from nuclear reactor safety tests. The boundary layer equations were formulated and solved for the limiting cases of extremely low and very high subcooling. (M.C.G.)

6082 TURBULENT BOUNDARY LAYERS IN COMPRESSIBLE GASES. S. S. Kutateladze and A. I. Leont'ev. Translated from the Russian by D. B. Spalding. New York, Academic Press, 1964. 489p.

The survey contains studies of: fundamental equations of turbulent boundary layers; laws of friction and heat transfer; flow along a flat impermeable plate; flow along a permeable plate; flow over curved surfaces; and flow through ducts. (T.F.H.)

6083 A METHOD OF PREDICTING STEAM SURGE TANKS TRANSIENTS BASED ON ONE-DIMENSIONAL HEAT SINKS. Eugene E. Drucker and Dannie J. Gorman (Syracuse Univ., N. Y.). 25p. (CONF-446-78)

From American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

An analytical method was developed for predicting pressure behavior in pressurized steam surge tanks during liquid insurge. The steam in the tank was considered as a thermodynamic system. The effects on the steam of work done through compression, heat lost through the steam boundaries, and a spray of cold droplets into the steam region were taken into consideration. A solution to the equations employed was obtained by means of an iteration method. Performance curves were determined with the use of an IBM-650 computer and results compared with those obtained experimentally. (auth)

6084 FREE CONVECTION FLOW WITH HEAT GENERATION. K. C. Tsao (South Dakota School of Mines and Tech., Rapid City, S. Dak.). 12p. (CONF-446-50)

From American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

An exact solution for unsteady laminar free convective flow in an infinitely long vertical annulus is presented. Fluid velocity corresponding to stepwise change of surface temperature and internal homogeneous (in space) heat generation that increases exponentially with time is obtained by Laplace transformation and its convolution theorem. Transient velocity distributions thus obtained yield pertinent information necessary in computing the rate of volume flow, average velocity in the annulus, and momentum flux at the wall surfaces. The change of fluid momentum due to large transient heat release is believed to be of practical significance. (P.C.H.)

6085 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Eric Charles Matthews, Thomas Thomson, and Leonard Wilfred Warren (to International Combustion (Holdings) Ltd.). British Patent 971,902. Oct. 7, 1964. Filed Nov. 27, 1959.

A heat exchanger for a nuclear reactor using liquid metal as coolant is described. The heat exchanger includes an inlet chest and an outlet chest for the first fluid, a plurality of flow tubes interconnecting these chests, an inlet chest and an outlet chest for the second fluid, and a series of flow tubes for the second fluid. No tertiary barrier fluid is required. In the event of failure of an individual element, it may be removed without affecting the remaining elements. (A.G.W.)

Materials Testing

6086 THE IMPORTANT MATERIALS PARAMETERS AFFECTING THE PERFORMANCE OF NUCLEAR REACTOR PRESSURE VESSELS. Robert D. Wylie (Southwest Research Inst., San Antonio). 20p. (CONF-512-14)

From American Society for Testing and Materials 67th Annual Meeting, Chicago, June 1964.

A review is presented on the present status of knowledge with respect to the two most important mechanisms that might result in a pressure vessel failure. Some of the fabricating practices that are important in establishing the condition of the pressure vessel prior to service are described. It is emphasized that, as design stresses increase, attention to details of fabrication and inspection in areas of stress concentration are important. To balance the cost, a suggestion is made that consideration be given to a sliding scale of requirements based on the relative probability of defect propagation that then is governed by the elastic stress concentration effect. (P.C.H.)

GEOLOGY AND MINERALOGY

General

6087 (NP-14532) COMPARISON OF EARTHQUAKES AND EXPLOSIONS. D. S. Carder and G. W. Gordon (Coast and Geodetic Survey, Washington, D. C.). Aug. 1962. 15p. (VESIAC-3193-VU)

Comparisons are made of seismic records of earthquakes and underground explosions. The explosions include Gnome, Hardhat, and NTS events. Differences in the frequency spectrum and relative trace amplitudes are discussed. (D.L.C.)

6088 (JPRS-26742(p.49-60)) THE USE OF RADIOACTIVE ISOTOPES IN CERTAIN HYDROMETEOROLOGICAL MEASUREMENTS AND INVESTIGATIONS. A. I. Danilin. (Translation).

A number of applications of radioisotopes in hydrometeorology are described. They include the measurement of water content and density in the snow cover, of moisture content of soil, of evaporation from the soil surface, and of suspended alluvium in water. (D.L.C.)

6089 VARIATIONS OF NITROGEN-15 ABUNDANCE IN SOILS. H. H. Cheng, J. M. Bremner, and A. P. Edwards (Iowa Agricultural and Home Economics Experimental Station, Ames). Science, 146: 1574-5(Dec. 18, 1964).

A survey of the isotopic composition of soil nitrogen has shown that there is variation in the abundance of nitrogen-15 in soils and in different forms of soil nitrogen. The variation detected is small, but it cannot be attributed to analytical errors and should be considered in studies of nitrogen transformation in soils when nitrogen-15 is used as a tracer. (auth)

Natural Radioactivity and Fallout

Refer also to abstract 5725.

6090 (CEA-R-2449) DONNEES THEORIQUES ET EXPERIMENTALES SUR LES APPAREILS DE DETECTION DES AEROSOLS SUR BANDE FILTRE EN DEPLACEMENT CONTINU. (Theoretical and Experimental Data Concerning Aerosol Detection Equipment Using a Continuous Rolling-Band Filter). Louis Chretien, Jean Cluchet, and Henri Joffre (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). June 1964. 42p. Dep.(mn).

Theoretical calculations are given concerning the activities present on the suction window, and in front of the detector placed a certain distance from this window. The calculation is effected in the case of the use of rectangular and circular suction windows, and it is assumed that the contamination of the air is constant and homogeneous. An experimental method for calibrating the equipment is presented and the charts required for the measurement of the concentration of atmospheric aerosols are given. An example is given of an application of this equipment in the case of a radioactive aerosol recorder: type E.A.R. 620 in use at the French Atomic Energy Authority. (auth)

6091 (HNS-1229-49) SOME HYDROGEOLOGIC FACTORS IN WATER CONTAMINATION BY NUCLEAR CRATERING. Stanley N. Davis (Bradberry (Carroll E.) & Associates, Los Altos, Calif.) July 20, 1964. For Hazelton-Nuclear Science Corp., Palto Alto, Calif. Contract AT(29-2)-1229. 32p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Study of patterns of groundwater flow around craters and undrained canals indicates that a nuclear excavation could serve as a source of continuing contamination to regional groundwater supplies. If the crater is above the water table, infiltration of rainwater may carry contaminants into underlying aquifers. If the detonation is below the water table, the crater or canal will intercept a portion of the water flowing through the aquifer and contaminate it. Generally, this contaminated water flowing from the crater would occupy only the upper portion of the aquifer. In low permeability rocks in an arid region, radiocontaminants would tend to concentrate in the bottom of the crater rather than move into the aquifer. In this location they could form a direct physical hazard. Accurate evaluations of cratering detonations will require additional information on the water-bearing characteristics of the material close to the crater or channel, as well as information on the rates of leaching of radionuclides from the blocky rubble. (auth)

6092 (HW-83723) EVALUATION OF RADIOLOGICAL CONDITIONS IN THE VICINITY OF HANFORD, JANUARY–JUNE, 1964. R. H. Wilson, ed. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 19, 1964. Contract AT(45-1)-1350. 35p. Dep.; $2.00(cy), 1(mn) OTS.

Comprehensive surveillance of the Hanford environs during the first half of 1964 showed that the amounts of radioactive materials present were well within the nationally accepted limits at all times and that releases of radioactive materials from the Hanford plants were adequately controlled. ^{32}P continued to be the radioisotope of Hanford origin that contributed the most exposure to individuals who ate locally caught fish in quantity. Radiological conditions in the Hanford environs were similar to those observed last year and the exposures received by people who live in nearby communities were not substantially different from those estimated last year. The one exception was an expected increase in the dose to the GI tract of Richland residents from use of the Columbia River for a water supply. (auth)

6093 (INS-R-24) TRITIUM MEASUREMENTS IN NATURE. A REVIEW OF THE WORK OF THE TRITIUM LABORATORY INSTITUTE OF NUCLEAR SCIENCES, NEW ZEALAND. C. B. Taylor, H. A. Polach, and T. A. Rafter (New Zealand. Inst. of Nuclear Sciences, Lower Hutt). July 1963. 64p. Dep.(mn).

This review describes the work and results of the program of tritium measurements made in New Zealand during the years 1956–1963. Descriptions are included of the sampling program, the electrolytical enrichment process, the process employed for the conversion of the enriched water to hydrogen gas, and the counting experiments carried out in low background Geiger counters using ethylamine as a quenching gas. The calculation procedures are reviewed and an interim report is given of the estimated accuracy of the quoted results. A wide variety of water samples from rains, rivers, geothermal bores and fumaroles, artesian systems, surface ocean waters, and ocean profiles have been examined, and their tritium concentrations are reported. The results show that tritium from hydrogen bomb testing is building up in the Southern Hemisphere. Tritium levels in rains vary considerably from month to month but definite evidence exists for the "spring leak" observed with other fallout products. The results support other evidence for a variation in tritium fallout with latitude. Preliminary results prove the value of the tritium method in certain hydrology problems, but difficulties in the interpretation of the results for geothermal discharge and for ocean profiles have become apparent. (auth)

6094 (NP-14390) RADIOACTIVE FALL-OUT MEASUREMENTS IN PAKISTAN, 1958–62. Askari Imam Hashmi (Pakistan Atomic Energy Commission, Karachi). 49p. Dep.(mn).

Some information are presented on nuclear explosions and the effects of delayed global fallout. Results are presented of fallout measurements (^{90}Sr deposition and

atmospheric radioactivity), and the risks of radiation exposure are evaluated. (D.L.C.)

6095 (NP-14506) ON-SITE GEOCHEMICAL AND GAMMA-RAY SPECTRAL MEASUREMENTS. Preliminary Technical Report–Part I. (Texas Instruments, Inc., Dallas). Nov. 15, 1961. Project VELA. Contract AF49 (638)-1083). 58p. (VESIAC-2178-VU)

Preliminary results of gamma ray spectral measurements in the Rainier, Orchid, and Antler areas show that the field spectra can be resolved into the component gamma-emitting fission products. Young fission products have gamma ray energies concentrated in the low-energy region of the gamma spectrum compared with old fission products and natural radioactivity. This will allow rapid airborne surveying for young fission products with a relatively simple spectrometer apparatus. Such a technique should be useful as a first approach in on-site work to look for any possible vented or microvented young fission products. Carbon dioxide in the subsurface gases shows distinct lows in surface fractured areas over old nuclear events and should be a useful long term on-site geochemical tool. Helium shows increased values in the subsurface gas over the Antler Event and shows promise of being an effective short-term indicator of buried nuclear events. (auth)

6096 (NP-14511) EFFECTS OF UNDERGROUND EXPLOSIONS ON THE CONCENTRATIONS OF RADON AND THORON IN SOIL GAS. Robley D. Evans, Hobart W. Kraner, and Gerald L. Schroeder (Massachusetts Inst. of Tech., Cambridge). Nov. 25, 1961. 41p. (VESIAC-3733-VU)

An investigation was conducted to study the effect of an underground explosion on radon and thoron soil gas content and the possibility of using the effect to detect such an explosion. Possible meteorological effects on the soil gas were studied. Soil gas samples were taken within 100 yards of ground zero and analyzed for radon and thoron. Radon and thoron concentrations and Tn/Rn ratios are given for the Antler and Chena events over periods of time ranging from 2 days before the event up to 6 weeks afterward. (D.L.C.)

6097 (NRL-6164) FILTER PACK TECHNIQUE FOR CLASSIFYING RADIOACTIVE AEROSOLS BY PARTICLE SIZE. PART 2. ISOTOPIC FRACTIONATION WITH PARTICLE SIZE. L. B. Lockhart, Jr., R. L. Patterson, Jr., and A. W. Saunders, Jr. (Naval Research Lab., Washington, D. C.). Aug. 18, 1964. Contract AT(49-7)-2435. 13p. Dep.(mn); $1.00(cy), 1(mn) OTS.

An evaluation of the relative distribution of some long-lived airborne fission products among several ranges of particle sizes has been carried out by the radiochemical analysis of individual air filters exposed in a pack. The relative quantities of radioactivity deposited on each of the filters in the packs have been found to vary considerably throughout 1963; however, each of the individual isotopes behaves in much the same manner so that the fractionation of isotopes relative to one another is slight. Though isotopic fractionation by filters of different characteristics has not been found to be of great significance, there are indications that a more sensitive separating procedure may show more differences between particles in the extreme size ranges. The observed differences have been small and variable, rather than organized, but the variations are too large to be accounted for by experimental error. The long-lived natural radioisotope ^{210}Pb has a distribution very similar to that of the fission products, but with some preferential concentration in the smaller size range. The differences are not sufficient to invalidate the use of collections made on less than perfect filters for estimating the relative fission product concentrations in the air or for the approximate age determination of bomb debris. (auth)

6098 (RISO-85) ENVIRONMENTAL RADIOACTIVITY IN DENMARK IN 1963. A. Aarkrog and J. Lippert (Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). June 1964. 112p. Dep.(mn).

The measurement of fallout radioactivity in Denmark in 1963 is reported. ^{90}Sr was determined in samples from all over the country of precipitation, soil, ground water, sea water, grass, dried milk, fresh milk, grain, bread, potatoes, vegetables and fruit, total diet, and human bone. Furthermore ^{90}Sr was determined in local samples of air, rain water, grass, sea plants, and animal bone. ^{137}Cs was determined in milk, grain products, potatoes, vegetables, fruit, total diet, pork and beef samples collected from the whole country, and ^{137}Cs was measured by whole-body countings in persons from different parts of the country. Estimates of the mean content of radiostrontium and radiocaesium in the human diet in Denmark from 1963 are given. Finally, regular surveys of environmental samples from the Risø area are given. (auth)

6099 (RISÖ-86) ENVIRONMENTAL RADIOACTIVITY IN THE FAROES IN 1963. A. Aarkrog and J. Lippert (Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). July 1964. 27p. Dep.(mn); Jul. Gjellerup, 87, Solvgade, Copenhagen K, Denmark.

The measurement of fallout radioactivity in the Faroes in 1963 is reported. Radiostrontium (and ^{137}Cs in most instances) were determined in regularly collected samples of precipitation, grass, milk, potatoes, sheep, fish, and drinking water. In addition, analyses of spot samples of soil, sea water, sea plants, whales, birds, vegetables, grain, cheese, eggs, and human deciduous teeth were carried out. Estimates of the mean contents of ^{90}Sr and ^{137}Cs in the human diet in the Faroes in 1963 are given. (auth)

6100 (RISÖ-87) ENVIRONMENTAL RADIOACTIVITY IN GREENLAND IN 1963. A. Aarkrog and J. Lippert (Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). July 1964. 22p. Dep.(mn); Jul. Gjellerup, 87, Solvgade, Copenhagen K, Denmark.

The measurement of fall-out radioactivity in Greenland in 1963 is reported. ^{90}Sr (and ^{89}Sr and ^{137}Cs in most instances) were determined in samples of precipitation, soil, sea water, vegetation, animals, and drinking water. Estimates of the mean content of ^{90}Sr and ^{137}Cs in the human diet in Greenland in 1963 are given. (auth)

6101 (SC-RR-64-1679) FALLOUT REPORT: BETA-GAMMA RADIOACTIVITY IN AIR AT SANDIA LABORATORY, JANUARY THRU JUNE 1964. R. E. Womelsduff (Sandia Lab., Albuquerque, N. Mex.). Sept. 1964. Contract [AT(29-1)-789]. 12p. Dep.; $1.00(cy), 1(mn) OTS.

Data are presented on the gross beta-gamma radioactivity (expressed as micromicrocuries per cubic meter) of air samples collected by the Health Physics Division of the Sandia Laboratory of Sandia Corporation during the first half of 1964. (auth)

6102 (WT-1817) DISTRIBUTION OF THE RADIOACTIVITY FROM A NUCLEAR CRATERING EXPERIMENT. John A. Miskel and Norman A. Bonner (California. Univ., Livermore. Lawrence Radiation Lab.). Sept. 1964. Project DANNY BOY. 23p. Dep.; $2.00 (OTS).

Radiochemical analyses were performed on fallout and particulate cloud samples. A few tenths of a percent of the nonvolatile fission products and 10-20% of the more volatile species were vented. A large fraction of the nonvolatile products fell out within 10 miles, whereas the major portion of the volatile products did not. (auth)

6103 RADIOACTIVE ANTIMONY ISOTOPES IN THE ATMOSPHERE. Pentti Kauranen (Univ. of Arkansas, Fayetteville). J. Geophys. Res., 69: 5075-80(Dec. 1, 1964).

High concentrations of ^{124}Sb and ^{125}Sb were observed in an investigation of atmospheric filter samples collected in connection with Project Star Dust in 1962 and 1963. ^{124}Sb, an (n, γ) activation product of ^{123}Sb, was especially abundant in samples from high northern latitudes and altitudes of 55,000 feet or more. A new 'wave' of ^{124}Sb seems to have reached sampling altitude between January and April 1963 and to have, except for some horizontal spreading, remained fairly stable in position through summer 1963. The ratio of ^{125}Sb to ^{90}Sr was usually found to correspond to values reported for the production ratio of those nuclides in thermonuclear

explosions. However, some samples collected at high northern altitudes in 1962 show an excess of ^{125}Sb; since these samples are also high in other activation products, it is assumed that ^{125}Sb was produced partly through second-order neutron capture in ^{123}Sb. (auth)

6104 LOSSES OF Sr^{90}, Sr^{89}, AND I^{131} FROM FALLOUT-CONTAMINATED PLANTS. William E. Martin (Univ. of California, Los Angeles). Radiation Botany, 4: 275-84 (Nov. 1964).

During the early period following local fallout, and during periods of maximal worldwide fallout, the entry of radionuclides into terrestrial food-chains is due primarily to the external contamination of plants and secondarily to the uptake of radionuclides from contaminated soil. Studies were undertaken to estimate the rates of radionuclide loss from fallout-contaminated vegetation and hence from the diets of herbivores living in a fallout field. On the fifth, fifteenth, thirtieth, and sixtieth days after an underground nuclear explosion (Operation Sedan) at the Nevada Test Site, plant samples were collected from twenty representative locations in the fallout field and analyzed to determine the concentrations (pc/g dry wt) of ^{90}Sr, ^{89}Sr, and ^{131}I at the times of collection. While the radioactive half lives of ^{90}Sr, ^{89}Sr, and ^{131}I are approximately 27.7 years, 53 days, and 8.04 days respectively, their average effective half-lives on fallout-contaminated plants, during the period from 5 to 30 days after the detonation, were 27.8 days, 17.8 days, and 5.0 days respectively. Losses of ^{90}Sr and ^{89}Sr were attributed to radioactive decay and to the removal of fallout particles and foliage by wind and/or other mechanical disturbances. Losses of ^{131}I were attributed to radioactive decay, to mechanical disturbance, and to the vaporization of ^{131}I from the fallout particles retained on foliage. (auth)

Site Survey and Selection

6105 (JUL-189-VW) EINE ANALYSE DER STANDORTBEDINGUNGEN FÜR REAKTOREN. (An Analysis of Location Conditions for Reactors). Harald Luks (Kernforschungsanlage, Jülich, Germany). July 1964. 132p. Dep.(mn).

General and special problems in site selection for reactors are discussed. Physical characteristics of a reactor, operating conditions, and environmental dangers are considered. The location as a function of reactor type, hydrological viewpoints, geological relations, topographical circumstances, meteorological conditions, population density, adjacent industries and other installations, soil uses in the environs, and traffic situations are discussed and evaluated. Accidents at reactors are reviewed. German and foreign reactor locations are described. (M.C.G.)

Techniques and Equipment

6106 (AFCRL-64-750) THEORETICAL STUDIES RELATED TO THE DETERMINATION OF SEISMIC ENERGY SOURCE DEPTH. Final Report. T. W. Spencer, W. L. Baker, J. W. C. Sherwood, D. P. Squier, and R. D. Tooley (California Research Corp., La Habra). July 15, 1964. Contract AF19(604)-8344. 191p. (AD-607238). $6.00(OTS).

A summary is presented of work on a number of different but related topics, as follows: The effect of seismic source depth on Rayleigh wave spectra is examined for a dissipative half space and for an elastic layer overlying an elastic half space. In the two-layer earth model, the higher-mode amplitude spectra increase relative to the fundamental as the source approaches the base of the crust. The exact ray theory and matrix method are in principle devices for obtaining the response of a layered system over a limited time interval. Both methods prove to be inefficient from the standpoint of automatic computation but useful in analyzing certain general properties of the response functions in multilayered systems. Geometric ray theory is used to study the effects of layer thickness and range on the refracted arrival along a high-speed layer embedded in an infinite medium. When the layer is thick compared with the dominant wavelength, the refracted arrival exhibits range-limited shingling and may consist of two or more events separated by equal time intervals which depend only on the layer thickness. The reflection of a plane compressional wave at a plane interface is analyzed with particular emphasis on the equation for continuity of the instantaneous energy flux. Inside the critical angle, Knott's equation gives continuity of the instantaneous flux, but beyond the critical angle Knott's equation must be replaced by three separate conditions. The partition of energy among the reflected and transmitted waves and the relative phases are tabulated for over 2000 cases to show the effect of systematically varying the compressional velocity ratio, the Poisson's ratios and the density. Deconvolution techniques are applied to the body wave phases generated by two explosions and an earthquake in an effort to reduce the distortion introduced by the transmission and recording systems. (auth)

6107 (NP-14516) VOLUNTEER SEISMOLOGICAL TEAMS. Technical Report No. 62-5. Keith Westhusing (Geotechnical Corp., Garland, Tex.). Mar. 20, 1962. Contract AF33(600)-41694. Project GNOME. 60p. (VESIAC-1655-VU)

Forty-three volunteer seismological teams participated in monitoring the 5-kiloton nuclear detonation of 10 December 1961. Nearly all the teams were within a radius of 600 miles of GNOME ground zero, located approximately 25 miles southeast of Carlsbad, New Mexico, and most were in or near the Delaware Basin. Standardized methods of calibrating the seismic equipment and synchronizing time references were required to obtain accurate data on the amplitudes and travel times of seismic waves. Calibration of seismograph systems was done by a weight-drop method. A voice count before and after the shot, as well as audible pulses each second, were transmitted over a special broadcast network to synchronize the timing. Gain settings were based on data from a previous nuclear detonation of comparable size. Seismic wave travel times for the Central United States were used to estimate times of first arrival at each team. As evidenced by the quality of records and considering the limited data available upon which to base operational procedures, the volunteer-team monitoring of the GNOME event was a successful effort. (auth)

6108 (NP-14524) REFLECTANCE STUDIES OF VEGETATION DAMAGE. Technical Summary Report No. 1, October 5, 1960–March 15, 1961. (Army Engineer Research and Development Labs., Fort Belvoir, Va.). 40p. (VESIAC-2170-VU)

Progress is reported on studies of on-site vegetation reflectance data from 250 to 2000 millimicrons collected to determine the effect of underground nuclear explosions on vegetation. An investigation of aerial photography as a means for detecting vegetation damage was undertaken. Data were obtained on 42 sample sites, including 25 trees, 9 shrubs, and 8 soils and rocks. A detailed list of samples by data site and reflectance curves for the samples is given. Individual curves for the Pinyon and Juniper trees and for the soil of the area were analyzed. Whereas three regions of the reflectance spectrum offered photographic recognition of living and dead Pinyon trees, only the infrared region of the spectrum offered possibilities of detecting dead Juniper trees in this environment. (H.M.G.)

6109 (NP-14525) SOIL DENSITY STUDIES (NUCLEAR AND THERMAL). Technical Summary Report No. 2, August 2, 1961–December 31, 1961. (Army Engineer Research and Development Labs., Fort Belvoir, Va.). Dec. 31, 1961. 24p. (VESIAC-2171-VU)

Progress is reported on studies designed to determine: if density changes occurring in soils where underground nuclear explosions have taken place can be detected by measurements with nuclear density-measuring instruments

or by thermal imaging techniques; and if these changes can be used to indicate differences between blast and non-blast areas. A third objective was to indicate areas of research and development to advance the state-of-the-art in equipment and techniques which might make the method favorable for detection of areas where underground nuclear explosions had occurred. The density changes in the soil greater than 300 feet from ground zero (outside the crater) were not great enough to be detectable with either type of nuclear instrumentation used in these tests. Inside 300 feet from ground zero (inside the crater) the density changes were visually detectable. No conclusion based on density measurements in this area can be made, as access for measurement was prohibited. Cracks in the soil due to the underground explosions, although visually detectable out as far as 900 feet from ground zero, were not detectable with the instrumentation because the cracks constituted only a minute part of the total soil volume affecting the instrument reading. The continuous-reading Qualicon 502 gauge cannot be used effectively to detect density differences in the soil because of extreme sensitivity to height variations and soil microrelief. There was no practical way to overcome this restriction in use. The hand-portable P-22 gauge was highly sensitive to the amount of air space between the detector head and the soil surface. With provisions, the P-22 gauge gave accurate and quite reproducible measurements of soil density. The blast site was detectable on T-2 thermal images during both day and night. While detection with thermal imaging equipment was successful, a much better view was possible with conventional photography and the unaided eye during daylight. At night the thermal images from a ground-based system such as the T-2 are only of marginal value without a prior knowledge of the general test site. Since a crater was formed by the only explosion tested, no conclusion could be made concerning the value of thermal imaging equipment for detection of underground explosions in the absence of surface topographic changes. (H.M.G.)

6110 (NP-14526) REFLECTANCE STUDIES OF VEGETATION DAMAGE. Technical Summary Report No. 2, March 15, 1961–August 15, 1961. (Army Engineer Research and Development Labs., Fort Belvoir, Va.). Aug. 15, 1961. 32p. (VESIAC-233-VU)

Data collected at the Nevada Test Site during the period June 20-28, 1961 in connection with research on underground nuclear explosion detection by reflectance measurements on plant life are presented. For pinyon foliage, four regions of the spectrum show sufficient contrast to allow a discrimination between living and dead: 0.3 to 0.5, 0.55 to 0.75, 0.78 to 1.28, and 1.28 to 2.0 microns. For juniper trees three regions appear satisfactory: 0.55 to 0.8, 0.82 to 1.2, and 1.2 to 2.0 microns. (H.M.G.)

6111 (NP-14527) REFLECTANCE STUDIES OF VEGETATION DAMAGE AND SOIL DENSITY CHANGES. Technical Summary Report No. 1, November 17, 1961–March 15, 1962. (Army Engineer Research and Development Labs., Fort Belvoir, Va.). Apr. 10, 1962. 34p. (VESIAC-3728-VU)

Progress is reported on studies designed to determine whether: soil density changes in areas where underground nuclear detonations have taken place can be detected by a nuclear density-measuring device; and if these changes can be used to distinguish between blast and non-blast areas. A third objective was to obtain on-site vegetation reflectance data from 250 to 2000 millimicrons in order to determine the effects of such detonation on vegetation. All plots showed a decrease in soil density following the underground blast. A comparison of reflectance curves revealed that there may have been a change in vegetation reflectance in the infrared that persisted for 8 or 9 days after the detonation. After this period, reflectance value again became normal. (H.M.G.)

6112 (FTD-MT-64-407) METHOD OF DETECTION AND IDENTIFICATION OF REMOTE EXPLOSIONS. V. S. Voyutskii (Voyutskiy). Translated from Razved. i Promysl. Geofiz., Vses. Nauchn. Issled. Inst. Geofiz. Metodov Razvedki, No. 50, 3-11(1963). 12p. OTS.

Explosions can be distinguished from earthquakes if the sign of the phase of the first arrival of seismogram waves can be determined. A method for recording remote explosions with asynchronous accumulation of signals is given which permits this determination. (D.L.C.)

6113 ISOTOPIC RATIO OF $^{234}U/^{238}U$ IN NATURAL WATERS AND UTILIZATION OF THE RATIO IN NUCLEAR GEOCHRONOLOGY. P. I. Chalov, T. V. Tuzova, and Ya. A. Musin (Inst. of Physics and Mathematics, Academy of Sciences, Kirgiz SSR). Izv. Akad. Nauk SSSR, Ser. Geofiz., No. 10, 1552-61(Oct. 1964). (In Russian)

A new nuclear geochronological method based on $^{234}U/^{238}U$ isotopic ratios was used for determining the age of two mountain lakes. An analysis is made of the advantages and disadvantages of the method for studying processes taking place in the ocean. (tr-auth)

6114 RUBIDIUM/STRONTIUM AGES FROM THE WESTERN TRANSVAAL. H. L. Allsopp (Univ. of Witwatersrand, Johannesburg). Nature, 204: 361-3(Oct. 24, 1964).

The age of granites as determined by the rubidium/strontium method is critically dependent on the value taken for the primary $^{87}Sr/^{86}Sr$ ratio (R_i). The estimation of R_i is discussed. The ages of a number of isolated granite samples are calculated, and new upper limits are established for the ages of the Ventersdorp, Transvaal, and Witwatersrand systems. (C.E.S.)

6115 ISOTOPIC AGES OF ASSYNT DYKES. C. R. Evans (Imperial Oil Enterprises Ltd., Calgary, Can.) and J. Tarney. Nature, 204: 638-41(Nov. 14, 1964).

An attempt was made on dykes from the Assynt and Scourie areas in Sutherland, Scotland, to establish, if possible, the period over which the dykes were intruded, and in particular to decide whether or not any of the fresh dykes are Laxfordian in age. Potassium was determined using a flame photometer coupled to an automatic strip recorder, and argon was determined by isotope dilution. The experimental error in measuring the potassium/argon ratio was small enough to give an error of less than ±50 m.y. on the ages quoted. The Rb/Sr ratio was also determined. Two hypotheses are given for an excess of argon found in the dyke samples. Treated as a whole the dyke ages show a distinct concentration at 220 m.y., with a steady fall off towards the Laxfordian. The results suggest that (in Assynt) the majority of the Scourie dolerites were intruded shortly before 2190 m.y. ago, while emplacement of other dyke types followed over a period that may have extended to as late as 1950 m.y. No dykes of Laxfordian age appear to be present. (P.C.H.)

6116 MEASUREMENTS OF CARBON-14 IN KNOWN AGE SAMPLES AND THEIR GEOPHYSICAL IMPLICATIONS. William Raymond Schell. Thesis, Seattle, Univ. of Washington, 1963. 115p.

The carbon-14 concentration in the atmosphere has been shown to vary appreciably since the last glaciation. Two possible explanations for the difference are proposed: (1) incorrect half-life of carbon-14, and (2) change in the $^{14}C/^{12}C$ ratio in the atmosphere due to changing oceanic characteristics. An attempt was made to explain errors in the method using accurately dated tree rings of Sequoia gigantea. Small samples were cut from two trees at 100-year intervals over a time-span of 2,600 years. These samples were treated to remove gums, lignins, etc., leaving pure cellulose. The cellulose was burned, converted to methane by a newly-developed method, and the carbon-14 content was analyzed in a thin-walled proportional counter similar in design to that of Oeschger, except that the inner chamber was leak-tight with respect to the outer chamber. Results of this study were compared with other tree ring studies and archeological carbon-14 dates and showed a definite trend not previously recognized. On the basis of the data, an effective half life of carbon-14 was calculated

at 5,833 ± 127 years. A mathematical model was also set up to attempt to explain the change in $^{14}C/^{12}C$ ratio with temperature since the last glaciation. This treatment involved isotopic fractionation of carbon-12, carbon-13, and carbon-14 with temperature, as well as the gross changes in the solubility of carbon dioxide in the ocean with temperature. It was concluded that the effective half life of atmospheric carbon-14 may, in fact, be the result of a change in oceanic characteristics. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

Thorium and Uranium Minerals

6117 ON THE GEOCHEMICAL COMPOSITION OF A SAMPLE OF THE GULSHAD REGION (CENTRAL KAZAKHSTAN). D. N. Ivanov (Steklov Mathematical Inst., Leningrad). Geokhimiya, No. 10, 1060-4(1964). (In Russian)

Correlations of quantitative mineralogical analyses carried out on 72 specimens of Gul'shad uranium bearing granitoids indicated a consistent geochemical relation to various types of rocks. For instance rocks with increased potassium and potassium feldspar contents but decreased plagioclase content showed increased uranium content. The low uranium contents of rocks with an abundance of transparent accessory minerals is explained by contamination by basic dark colored materials. Tables of uranium contents are included. (R.V.J.)

6118 A STUDY OF $^{234}U/^{238}U$ RATIO IN NATURAL SAMPLES. Masanobu Sakanoue and Tetsuo Hashimoto (Kanazawa Univ., Japan). Nippon Kagaku Zasshi, 85: 622-7(Oct. 1964). (In Japanese)

Two methods of measuring the $^{234}U/^{238}U$ ratio were examined: the method using the relationship between α and β activity and the method of analysis of the α spectrum. In order to ascertain complete separation of both Th and Ra which may complicate the α spectrum of ^{234}U, a tracer solution was added to the sample solution. Uranium in natural waters was coprecipitated with $AlPO_4$ and then purified by ethyl acetate extraction from HNO_3 solution and anion exchange procedure with 8N HCl solution. In the latter step, complete removal of thorium had to be confirmed by measuring the activity of the tracer in the washing solution (8N HCl). After the elution with 0.1N HCl, uranium was electrodeposited on stainless steel plate (3.5 cm. ϕ) from the acetate-buffered solution by constant-current electrolysis. This plate was mounted in the gridded ionization chamber and the α spectrometry was carried out by multichannel pulse height analysis. It was found that $^{234}U/^{238}U$ ratios in some mineral spring waters of Japan have the values of more than unity (1.6 etc.) in eU unit or in activity ratio. (auth)

6119 GEOLOGICHESKIE PREDPOSYLKI POISKOV MESTOROZHDENII URANA. (Geological Prerequisites in Prospecting for Uranium Deposits). V. I. Krasnikov. Moscow, Atomizdat, 1964. 188p.

Topics discussed are: types of uranium deposits, geological prerequisites on searching for such deposits, dispersion halos as indicators of uranium deposits, natural conditions of prospecting work, and zoning of investigated territories according to prospecting conditions. Ninety-seven references. (IIC-MG)

HEALTH AND SAFETY

Refer also to abstracts 5600, 5761, 6092, 6185, 6204, 6224, and 6880.

6120 (AD-420449) PHYSIOLOGICAL AND PSYCHOLOGICAL EFFECTS OF OVERLOADING FALLOUT SHELTERS. Final Report. Donald T. Hanifan, W. Vincent Blockley, Meredith B. Mitchell, and Peter H. Strudwick (Dunlap and Associates, Inc. Western Div., Santa Monica, Calif.). Apr. 15, 1963. Contract OCD-OS-62-137. 366p. $21.00 (OTS).

This study was carried out to analyze the physiological and psychological factors limiting the survivable loading of fallout shelters, to determine the areas in which further information is most needed, and to suggest experiments for obtaining that information. The report discusses the purpose and scope of the investigation, provides a definition of overloading and discusses its etiology and likelihood of occurrence, and considers the man-shelter-environment interaction in parametric terms. The significance of population characteristics and variability is discussed and a preliminary attempt is made to define the population of interest. The most outstanding environmental variables are listed and briefly considered, after which physiological and psychological variables are examined in considerable detail; an approach to predicting the effects of variables in combination is then presented together with a first cut at analyzing two-at-a-time variable interaction. Physiological response to probable shelter environments is discussed with particular emphasis given to the effects of excessive heat, carbon dioxide and certain toxic atmospheric contaminants; and to the effects of inadequate oxygen, food and water. (auth)

6121 (CEA-Bib-48) LISTE D'INCIDENTS SURVENUS A DES REACTEURS ET DANS DES INSTALLATIONS NUCLEAIRES. (List of Incidents Which Have Occurred in Reactors and in Nuclear Installations). Yves Sutra Fourcade (France. Commissariat à l'Énergie Atomique. Centre de Production de Plutonium de Marcoule, Chuscian). 1964. 110p. Dep.(mn).

The accidents and incidents which have occurred since nuclear energy has been used industrially are listed. The list includes the majority of serious accidents and a certain number of minor incidents which are given mainly as examples. The more notable accidents are treated in detail and all the essential information known about them is summarized. (C.H.)

6122 (CEA-R-2432) ETUDE DU POUVOIR D'ARRET DE DIFFERENTS FILTRES. (Study of the Stopping Power of Various Filters). Guy Madelaine (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). Oct. 1964. 67p. Dep.(mn).

A study was made of aerosols obtained from the combustion of various smoke-producing compounds. A trial aerosol of which the size distribution is the closest possible to that of atmospheric dusts was defined. The efficiency of various filters was determined for successive increments of the dimensions and not for the whole range of its diameter distribution. The variation in the efficiency of the filtering layers as a function of the filtering speed and particle size was studied for aerosols having particle diameters of over 0.3 μ. An original method is described for measuring the efficiency of filters for ultrafine particles (under 0.1 μ) using the fixation properties of radioactive atoms resulting from the decay of thoron. (auth)

6123 (CONF-555-14) ECONOMICS OF BUILDING DECONTAMINATION. Peter Loysen (New York Operations Office. Health and Safety Lab., AEC). [nd]. 17p. Dep. (mn); $1.00(cy), 1(mn) OTS.

From International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964.

Information was obtained on the decontamination of five buildings contaminated with radioactive materials. The buildings varied in area, type of structure, contaminant, and standard of cleanliness required. The degree of cleanliness that was achieved by decontamination varied depending on the future use of the facility. The contaminated areas ranged in size from about 8,000 square feet to 30,000 square feet. The five sites included: a truck terminal accidentally contaminated with plutonium, two uranium and beryllium fabrication shops, a plutonium processing facility, and a radium dial painting factory. Valuable information regarding the best approaches to decontamination problems can be gleaned from the actual experiences reported. In evaluating the economics of decontaminating the buildings, the costs for labor, health physics surveillance, supplies and equipment, and waste disposal are all considered. While definite conclusions cannot be drawn from the cost data alone because of the many variables involved in each case, the choice of residual contamination limits was found to be a major influence on the costs of decontamination. (auth)

6124 (COO-119-230) SAFETY MANUAL. Charles W. Mays, David H. Taysum, Ray D. Lloyd, and David R. Atherton, comps. (Utah. Univ., Salt Lake City. Coll. of Medicine). July 1964. Contract AT(11-1)-119. 31p. Dep. (mn); $2.00(cy), 1(mn) OTS.

Safe procedures for handling radioactive materials and toxic chemicals are described. Of special interest is a section detailing appropriate measures to take following a radiation accident to decrease the body burden of internal radioactivity. (auth)

6125 (HW-80913) PULSED NEUTRON SOURCE MEASUREMENTS OF THE Z-9 CRIB. S. R. Bierman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 17, 1964. Contract AT(45-1)-1350. 9p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Pulsed neutron source measurements were made on a crib in the Hanford 200 West Area to determine the feasibility of using neutron bursts for making subcritical reactivity measurements. Results of the measurements are given and analyzed. (J.R.D.)

6126 (HW-83605) PROGRESS IN RADIOLOGICAL PHYSICS. A SUMMARY OF HANFORD LABORATORIES ACHIEVEMENTS IN THESE PROGRAMS UNDER GENERAL ELECTRIC, 1947–1964. W. C. Roesch (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 1964. Contract AT(45-1)-1350. 88p. Dep.; $3.00(cy), 2(mn) OTS.

Work accomplished from 1947 through 1964 in the improvement of the quality and reduction of the expense of radiation protection at Hanford Laboratories is summarized. Topics discussed include the development of new instruments and techniques and the results of theoretical and research studies. Data are included on the development of whole-body counters, the development of neutron dosimeters, the development of radiation calorimeters; the development of γ and β dosimeters, results of studies on the dosimetry of radiation accidents and the radiosensitivity of gonads; and results of studies of radiation damage in graphite. 139 references. (C.H.)

6127 (K-1624) ANALYSIS OF THE USE OF SOLUBLE NEUTRON ABSORBERS IN DIFFUSION PLANT EQUIPMENT. J. C. Bailey, A. J. Mallett, C. E. Newlon, O. W. Hermann, and W. T. Mee (Oak Ridge Gaseous Diffusion Plant, Tenn.). Dec. 16, 1964. Contract W-7405-eng-26. 55p. Dep.; $3.00(cy), 1(mn) OTS.

This study was undertaken to consider the nuclear safety aspects of catastrophic fires or non-nuclear explosions in cascade equipment, including the possible use of a soluble neutron absorber in plant fire water systems. The study indicates that a neutron absorber concentration

of 14 grams boron per liter in plant sprinkler systems, added in the form of a boric acid–borax mixture, would essentially preclude a criticality incident during such contingencies. Results of the detailed nuclear safety analysis, which includes both homogeneous and two-region criticality models, are given in conventional mass units. The DTK multigroup transport code was used for all criticality calculations in this study. (auth)

6128 (NRL-6165) PERFORMANCE CHARACTERISTICS OF THE FPP-15 FILTER MATERIAL USED IN THE USSR FOR ENVIRONMENTAL RADIOACTIVITY MONITORING. R. L. Patterson, Jr., L. B. Lockhart, Jr., and W. L. Anderson (Naval Research Lab., Washington, D. C.). Aug. 19, 1964. Contract AT(49-7)-2435. 8p. Dep.(mn); $1.00(cy), 1(mn) OTS.

A survey of the physical properties and operational characteristics has been made of the FPP-15 filter paper widely used in the Soviet Union for monitoring airborne radioactivity. This filter material is composed of a thin mat of small-diameter, unoriented fibers of polyvinyl chloride deposited on a cotton scrim backing. Due to its composition, the filter readily picks up an electrostatic charge which causes some difficulty in handling but which contributes to an increased initial retentivity toward submicron aerosol particles. Functionally, the filter combines low resistance to air flow with good retentivity toward fission-product aerosols. (auth)

6129 (ORNL-3735) RESULTS OF IMPACT TESTS PERFORMED ON 55-GAL. DRUM-TYPE BIRDCAGES. L. B. Shappert (Oak Ridge National Lab., Tenn.). Dec. 1964. Contract W-7405-eng-26. 59p. Dep.; $3.00(OTS).

In order to prevent criticality incidents from occurring in the shipment of fissionable materials, such materials are contained in geometrically safe containers (birds) which are kept at a safe spacing by building a framework (birdcages) around each container. In the event of a shipping accident, the framework may be distorted sufficiently to reduce the spacing to unsafe values. Therefore, impact tests were made to simulate accident conditions in order to evaluate the extent of the distortion and to improve the birdcage design in order to reduce deformation. It was found that wooden and steel braces of the type tested are not sufficient to keep the bird positioned in the center of the drum after a 30-ft free fall onto an unyielding surface. However, by welding thin steel-bearing plates to the end of the steel braces, impact resistance is greatly improved and the bird will remain in the center of the drum after impact. (auth)

6130 (USNRDL-TR-789) DESIGN CRITERIA FOR ROOF WASHDOWN. PHASE II. FALLOUT REMOVAL STUDIES ON TYPICAL ROOFING SURFACES FOR THREE SIZE RANGES OF PARTICLES (44 TO 88 μ, 88 TO 177 μ, AND 590 TO 1190 μ). R. H. Heiskell, W. S. Kehrer, and N. J. Vella (Naval Radiological Defense Lab., San Francisco). Aug. 11, 1964. 68p.

Fallout simulant particles ranging in size from 44 to 88, 88 to 177, and 590 to 1190 μ were deposited at a rate of approximately 2 grams/min/ft^2 for a period of 30 min on selected typical roof sections 48 ft long by 8 ft wide, to determine the effect of water flow rate, slope, and surface type on washdown effectiveness. A residual mass of less than 10% of the 590 to 1190 μ particles was obtained on aluminum shingles, composition shingles, roll roofing, corrugated metal and fiberglass epoxy laminated roof with a maximum of 3.5 gpm/ft of roof width at a slope of 1 : 8 or greater. Thirty-five to forty-five per cent of the 88 to 177 μ particles was retained on the corrugated metal at this same slope with a water flow of 3.5 gpm/ft of width. A residual of 5% or less was obtained on roll roofing at a slope of 1 : 8 or greater with a water flow of 3.5 gpm/ft of width with both the 88 or 177 and 590 to 1190 μ particles. With the same two particle sizes, a residual of 5% or less was obtained on a fiberglass epoxy laminated roof with a maximum water flow of 1.0 gpm/ft of width at a slope of 1:12 or greater. (auth)

6131 ABSORPTION AND CLINICAL DOSIMETRY OF BETA-RADIATION. Gil Gayarre and C. Fisicas (Clinica de Medicine Fisica, Madrid). Acta Iberica Radiol.-Cancerol., 17: 1-24(1962). (In Spanish)

The physical and mathematical problems in the determination of the absorption and clinical dosimetry of beta radiation are different according to the clinical and geometric characteristics of the beta emitters. The characteristics of sources internally administered, of interstitial emitters or point sources, and of surface emitters or cylindrical or plane sources with homogeneous distribution of the radioactive substance over the surface were investigated individually by review of pertinent data. (J.S.R.)

6132 RADIATION PRECAUTIONS AND DECONTAMINATION PROCEDURES IN THE NUCLEAR MEDICINE LABORATORY. Albert J. Gilson and Raymond E. Parks (Univ. of Miami, Fla.). Ind. Med. Surg., 33: 492(July 1964).

A brief discussion is presented concerning the utilization of radioactive materials in clinical nuclear medicine. Such uses fall into two basic groups: low-activity levels or those procedures utilizing levels of activity below one mC and high-activity levels, or those procedures involving the use of one mC or more of radioactive material. In general, the low level group encompasses all diagnostic studies whereas the high level group is confined to the therapeutic use of radioisotopes. A further subdivision is considered: those radioactive materials which present a problem solely related to external exposures such as sealed radioisotope sources, as opposed to those isotopes which are basically of little importance as an external radiation hazard but if ingested create an acute radiation problem because of their metabolic pathways and long effective half lives. The safe handling of these radioactive materials in the nuclear medicine laboratory is dependent to a large degree on several basic concepts: (1) laboratory design, (2) radiation shielding and isotope storage, (3) proper handling tools, (4) accurate record keeping, (5) safety surveys and monitoring, (6) strict adherence to radiation hygiene rules and regulations by laboratory personnel, and (7) efficient methods for radioactive decontamination. (BBB)

6133 THE PUBLIC HEALTH SERVICE ROLE IN RADIOLOGICAL HEALTH. James G. Terrill, Jr. (Public Health Service, Washington, D. C.). Ind. Med. Surg., 33: 497(July 1964).

The function of the Public Health Service in maintaining standards of radiological protection is briefly outlined. It has the function of stimulating state and local radiological health programs through consultation, temporary assignment of personnel, loan of equipment, training of state personnel, and providing funds through a system of matching grants. The Public Health Service also has an important role in providing much of the technical data which forms a basis for standard setting and plans for control of radiation exposure. The Federal program, as well as any other comprehensive radiological health system, includes four major elements: (1) identification and measurement of all sources of radiation exposure; (2) evaluation of these exposures; (3) development and application of methods of control; and (4) education, training and public information. (BBB)

6134 DEFLECTOR TO PREVENT SUCTION OF SMOKE INTO CHIMNEY SLIPSTREAMS AT HIGH WIND SPEEDS. R. Salle (CEA, Paris). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 39-44.

Wind tunnel experiments have been made on smoke leaving a chimney under conditions when the smoke velocity is less than that of the cross-wind blowing across the stack. Model chimneys were used, some equipped with special devices for eliminating the drawing-down of smoke into the chimney slipstream that normally occurs in this situation, others with no special devices. On the basis of these studies, a new device has been developed to increase the effective chimney height, this device consisting of two conical collars placed around the top of the chimney, the upper collar having the broad base of the collar facing downward, the lower collar with the broad base facing up. Penetration of the smoke into the slipstream is largely prevented by the

continuous layer of air flowing horizontally through the space between the two collar bases, providing that these are properly dimensioned and positioned. Using alcohol vapor as a synthetic smoke, air concentrations have been measured in the lee of the model chimney for various wind speed/smoke speed ratios under the following conditions: (a) unequipped, (b) equipped with previously developed devices and, (c) equipped with the new device. (The instrument used in measuring the relative alcohol concentrations is described.) Aerodynamic forces and currents at the collars of the new device have also been determined. (auth)

6135 UTILIZATION OF SPECIALIZED FILTER HOUSINGS INCORPORATING BAG-OUT FEATURES FOR RADIOACTIVE CONTAMINATION CONTROL. J. Duteil (Saint Gobain Nucleaire, Courbevoie Seine, France). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 377-80.

A filter housing is described which facilitates the removal of contaminated filter elements without breaking the air seal. The construction of the housing, contamination control, and operation are discussed. (D.L.C.)

6136 DECREE OF THE PRESIDENT OF THE REPUBLIC. PLANT SAFETY AND HEALTH PROTECTION OF WORKERS AND THE POPULATION AGAINST THE DANGERS OF IONIZING RADIATION FROM THE PEACEFUL USES OF NUCLEAR ENERGY. Riv. Ing. Nucl., 2: 381-412 (May-June 1964). (In Italian)

Legislation enacted on February 13, 1964, on plant safety and the protection of workers and population against radiation is presented in full. (J.S.R.)

6137 TECHNICAL AND LEGAL PROBLEMS IN SAFETY OF NUCLEAR PLANTS IN THE LIGHT OF THE PRESIDENTIAL DECREE (NO. 185; FEB. 13, 1964) ON SAFETY OF PLANTS AND PROTECTION OF THE HEALTH OF WORKERS AND THE POPULATION. Enzo Iansiti. Riv. Ing. Nucl., 2: 413-18(May-June 1964). (In Italian)

6138 USE OF COMMERCIAL DETERGENTS IN WASHING CONTAMINATED COTTON GARMENTS AND TREATMENT OF RESULTING LIQUID. D. Boenzi and G. Branca. Riv. Ing. Nucl., 2: 419-43(May-June 1964). (In Italian)

The degree of decontamination obtainable with commercial detergents under various experimental conditions was evaluated. The effects of detergent concentration, type of detergent, temperature, type of material to be decontaminated, and contamination conditions of the garments were determined. The efficiency of calcium ferrophosphate flocculation in the treatment of the residual solutions was evaluated. (J.S.R.)

6139 AN APPROACH TO LEAK TESTING OF SEALED RADIUM SOURCES. John C. Villforth and Philip McClain. 11p. (CONF-642-10).

From Health Physics Society, Cincinnati, June 1964.

Two extrapolation factors are calculated for each of two leakage determination methods. The first extrapolates an instantaneous alpha count back to the total counts associated with the original radium which created this activity, and the second extrapolates an instantaneous beta count in the same manner. (P.C.H.)

6140 PROTECTIVE CHAMBER INTENDED TO CONTAIN RADIOACTIVE ELEMENTS. Jacques Pommier and Georges Veil (to Commissariat à l'Energie Atomique). British Patent 971,105. Sept. 30, 1964. Priority date Oct. 25, 1961, France.

A protective receptacle with Pb walls intended to contain radioactive materials is described. The radioactive material to be housed in the receptacle is inserted into a container that fits in a cavity in the receptacle. A plug for closing the container is mounted on the inside of the receptacle cover, and means are provided for applying the plug to the container after the cover is closed. The plug is then released from the cover so that it remains on the container when the receptacle is opened. Means for inserting the container into and withdrawing it from the cavity involve a plunger slidable in the cavity and movable by means external to the receptacle. (A.G.W.)

INSTRUMENTATION

General

Refer also to abstract 6717.

6141 (AFCRL-64-373) DESIGN AND EVALUATION OF AN ION BEAM DELAY LINE. Final Report. Robert C. Siegel and Edwin Langberg (Elcon Lab., Inc., Peabody, Mass.). Apr. 30, 1964. Contract AF19(628)-2762. 81p. (AD-601898) $2.25 (OTS).

The theory and evaluation of a signal delay technique based on the travel time of an ion beam through an equipotential drift space filled with plasma are examined. Attention is given to plasma potential distribution and the control of particle trajectories by the use of magnetic and electrostatic-sheath focusing. Emission characteristics of nickel and tungsten in a cesium environment, sheath phenomena, space-charge neutralization, design data, construction techniques, and evaluation tests are described in detail. Results indicate the basic soundness of the ion beam delay line concept. Ultimate characteristics of a tube using this technique could reasonably include bandwidths from d. c. to 40 Mc or higher, voltage controlled delay from several microseconds to a millisecond, low insertion loss, and a noise level no greater than that due to the random fluctuation of ion current. (auth)

6142 (ARL-64-82) RESEARCH IN HIGH-TEMPERATURE X-RAY DIFFRACTION TECHNOLOGY. S. M. Lang and E. W. Franklin (Owens-Illinois Glass Co., Toledo). May 1964. Contract AF33(616)-7470. 77p. (AD-603584). $3.00(OTS).

High accuracy (0.005 degree 2-theta) and high precision (0.002 degree 2-theta) for x-ray diffraction measurements at angles from less than zero to 155–160 degrees 2-theta at sample temperatures to 2600–2800°C in oxidizing, neutral, reducing, or evacuated atmospheric environments are characteristics of a high-temperature x-ray diffractometer system specifically designed for research studies. Within the noble-metal thermocouple temperature range, very rapid thermal equilibrium — 500°C intervals in less than 3 seconds — can be attained. The crystallometry of zirconium dioxide, ZrO_2, has been surveyed in the range from room temperature to 1750°C in normal air atmosphere at ambient pressure. Topics studied in some detail have been (a) the hysteresis of the monoclinic-tetragonal zirconia transformation, (b) the axial thermal expansion of tetragonal zirconia to 1750°C, (c) the determination of axial expansion data for platinum and beryllium oxide for use as sample temperature indicators, and (d) new mathematical solutions of the classical d-value equations for lattice constants calculations. It has been shown that significant physical properties and constants can be measured for ZrO_2 if the oxygen stoichiometry is established and maintained at an (unknown) equilibrium, or pseudo-equilibrium, value. (auth)

6143 (AWRE-O-76/64) PARTICLE SIZE ANALYSIS IN THE SUB-SIEVE RANGE WITH AN AWRE CENTRIFUGAL PHOTOSEDIMENTOMETER. M. W. G. Burt (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Aug. 1964. 44p. Dep.(mn).

A new instrument for the measurement of particle size in the sub-sieve range is described. It consists of a disc-shaped centrifuge in which the suspension is analyzed by measuring the optical density at a fixed point. Tests have given consistent and meaningful results on a variety of materials. (auth)

6144 (CEA-R-2447) REALISATION D'UNE INSTALLATION D'ANALYSE THERMIQUE DIFFERENTIELLE RAPIDE. (Construction of a Fast Differential Thermal Analysis Apparatus). Goulven Vernois (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). Oct. 1964. 96p. Dep.(mn).

An analysis is made of the various possibilities of DTA as well as conventional installation set-ups. It is shown that by varying simultaneously the heating rate and the size of the samples, it is possible to obtain very similar thermograms. The advantages of fast heating rates are given, and a type of oven and types of crucible are proposed which allow heating rates of over 1° per second, rapid manipulation, a controlled atmosphere (from a vacuum up to high pressures) and forced cooling. Details of research carried with this type of installation showing the quantitative nature of the analyses and, as an example, the influence of a grinding on the qualitative and quantitative results are given. (auth)

6145 (EUR-1831.e) ESONE SYSTEM OF NUCLEAR ELECTRONICS. (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1964. 16p. Dep.(mn).

The Esone system of instrumentation was developed in cooperation among nuclear research centers of the Community and other institutions and national and international laboratories, allowing a better collaboration between research institutions. The Esone system is used as a guide for the construction and testing of electronic instrumentation in nuclear research centers. The use of the system will allow the exchange of instruments and designs and complementary work of development. This system was adopted by the laboratories of the European Atomic Energy Community and other laboratories in Europe. It applies to specified categories of instruments. It is intended that the adoption of this system does not limit the utilizers in the freedom of choice and purchase of electronic equipment. (auth)

6146 (NIRL/R/69) A METHOD OF IMPROVING THE RESOLUTION OF TIME SORTERS. M. F. Audus (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Chilton, Berks, England). June 1964. 18p. Dep.(mn); $0.60(BIS), 3s.(HMSO).

There are a number of experiments proposed for Nimrod in which time sorters will find application. The factors affecting their resolution and means for improving the resolution are examined. Experimental results are given, which compare two methods of improving resolution. Finally an analysis of these results is presented, which enables the resolution to be expressed in more useful form. (auth)

6147 (ORO-622) A SEDIMENT DENSITY METER. Billy F. Wilson (Lane-Wells Co., Houston, Tex.). Apr. 1964. Contract AT(40-1)-3118. 52p. Dep.; $2.00(OTS).

A Sediment Density Meter has been developed for in situ measurement of ocean bottom materials in the range from about 1.0 to 2.0 g per cc. The measurement is based on the scattering of gamma rays from a radiation source contained in the device, which is lowered on a cable into unconsolidated sediments. The gamma ray intensity is measured by a Geiger counter assembly and is photographically recorded by a camera in the instrument while the sensing probe is moved stepwise upward from solid bottom through a range up to eleven feet of sediments. The device is about 26 feet long and is powered by self-contained batteries. (auth)

6148 (RT/GEO(64)-13) DISPOSITIVO PER OTTENERE IL PROFILO FOTOMETRICO DEGLI SPETTROGRAMMI UNITAMENTE ALLA LORO PROIEZIONE. (Apparatus for Obtaining a Photometric Profile Together with a Spectrogram Projection). F. Tonani (Italy. Consiglio Nazionale Delle Ricerche. Centro Studii Geochimica, Florence) and D. Visibelli (Italy. Comitato

Nazionale per l'Energia Nucleare, Rome). July 1964. 25p. Dep.(mn).

The instrument described shows on the screen of an oscilloscope the outlines of a portion of the image of a spectrogram projected by a spectral lines comparator. Since the frequency of the exploration is 12.5 Hz, the examination of the photometric profile proceeds in a continuous manner with the visual observation of the spectrograms. The ordinate of the profile gives approximately the measure of the density of the spectral image. Measurements of the central density of spectral lines are obtainable with an error of about 0.02 on the difference between the density of two lines. The major advantage of the instrument is the speed of selection of the spectra lines, also under very unfavorable conditions. (auth)

6149 (SGAE-CH-6/1964) VERBESSERUNG DER REPRODUZIERBARKEIT DER TROPFENFALLMETHODE DURCH SCHRAGSTELLEN DES FALLROHRES. (Improvement of the Reproducibility of the Falling-Drop Method by Inclination of the Tube). E. Proksch, H. Bildstein, H. Eschweiler, and F. Wiesinger (Osterreichische Studiengesellschaft für Atomenergie G.m.b.H. Institut für Chemie, Seibersdorf). [1964]. 12p. Dep.(mn).

The falling-drop method used frequently for the density determination of aqueous solutions or for the isotopic analysis of water, may be increased considerably in its reproducibility by positioning the falling tube inclined rather than vertical. Instead of falling freely, the drops roll down the wall of the falling tube. Provided that the wall surface is sufficiently flat and uniformly coated with water repellants, the drops are guided exactly on their way and are less susceptible to perturbations by liquid motion, etc. (auth)

6150 (TID-21374) THE DEVELOPMENT OF A COLLIMATOR FOR THE HYBRID RADIOISOTOPE SCANNER (thesis). Ronald Joseph Martone (Rochester, N. Y. Univ. School of Medicine and Dentistry). 1964. 96p. Dep(mn); $3.00(cy), 2(mn) OTS.

Several collimators were developed for the Hybrid Scanner, a new device in the field of radioisotope mapping techniques. The collimators are of the multi-aperture focusing array type, using arrays of tubes in mercury. The prototype using a parallel array of glass rods was used to study the response of the crystal, and other prototypes were also developed, including a semi-focusing array with apertures formed by epoxy tape. (D.L.C.)

6151 (USNRDL-TR-775) A FAST, PUNCHED-CARD READOUT SYSTEM FOR PULSE-HEIGHT ANALYZERS. B. A. Euler, P. L. Phelps, and D. F. Covell (Naval Radiological Defense Lab., San Francisco). June 16, 1964. 40p. (AD-450634)

Digital computer techniques are applied to the analysis of pulse height spectra in gamma scintillation spectrometry. An IBM-523 Gang Summary Punch, in conjunction with a specially built buffer unit, is used to provide punched card readout from a 256-channel pulse height analyzer. Complete readout is accomplished in 12 seconds. The use of punched cards contributes the additional advantages of an easily organized data file and ready accessibility to the data. The card-punch buffer unit is capable of converting binary-coded decimal notation to binary notation. It has an eight-word AND gate matrix, which allows the insertion of seven record-identification and information words into the punch card readout, along with the 256 words of pulse height data. (auth)

6152 (WAPD-TM-343) EXPERIMENTAL AND ANALYTIC STUDIES OF ELECTROMECHANICAL TRANSDUCER SYSTEMS FOR TRANSIENT PRESSURE MEASUREMENTS. T. W. Hunt (Westinghouse Electric Corp. Bettis Atomic Power Lab., West Mifflin, Penna.). Aug. 1964. Contract AT-11-1-GEN-14. 55p. Dep.(mn); $3.00 (cy), 2(mn) OTS.

Six electromechanical pressure transducer systems consisting of variable reluctance transducers, tubing, valves, and fittings with water as the pressure transmitting fluid were designed, built, and tested. The systems were used to measure transient pressure drops caused by transient flow conditions in thermal and hydraulic experiments which simulate nuclear heating of pressurized water reactors through electrical heating of test sections. The frequency response and damping factor measurements for twenty-one combinations of transducer rating and system design are tabulated. The effect upon response and damping of various sizes of orifices is also tabulated. Thus, the data and system designs can be used to produce similar systems with the desired frequency response and damping. Two methods of testing were used. The first used the breaking of a glass plate to relieve suddenly a pre-set pressure and initiate a step-function pressure decrease which resulted in a transducer system response which was measured. This test method could only be performed near atmospheric pressure and required great care in venting the fluid system. The second method of testing was performed up to 2000 psia at ambient temperatures. A pressure step of 0.1 to 50 psia was also produced with this system and the response was again obtained. The two systems were found to agree if the low pressure test arrangement was sufficiently free of air. The high pressure test system afforded an easy way of determining if air was present, and the effects of air upon the transducer system performance. The natural frequency of the system could be predicted with reasonable accuracy. However, the measured damping factor generally ranged from 20 to 300% higher than predicted. The desired damping factor of nearly unity could be produced by trial and error insertion into the tubing of small diameter orifices ranging in size from 5 to 18 mils. (auth)

6153 NUCLEAR MAGNETIC RESONANCE SPECTROMETER IN A WEAK FIELD. V. V. Ekaterinin, A. I. Zhernovoi, and G. I. Yakovlev. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 58-62(1963). (In Russian)

Descriptions are given of the design and performance of a nuclear magnetic resonance spectrometer using a continuous flow counter with preliminary polarization and capable of measuring relaxation times from 0.2 to 3 sec. The spectrometer was used for measuring longitudinal relaxation times for split lines by means of additional demagnitization. Measurements on hypophosphate in water in a 35 Oe field showed three lines: one water proton line and two hypophosphite proton lines. The relaxation time as a function of concentration at various temperatures was plotted. (R.V.J.)

6154 THE DESIGN BASIS FOR PINHOLE GAMMA-RAY CAMERAS. M. A. Greenfield (Univ. of California, Los Angeles) and R. L. Koontz. Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 193-206.

Results are presented of a study of the design and use of pinhole gamma-ray cameras in examining irradiated fuel rods nondestructively at the Hallam Nuclear Power Facility. A theory is presented for the performance in terms of sensitivity, resolution, field of view, contrast, and magnification. The performance is described in terms of parameters that are analogous to those used in describing ordinary visible light cameras. Several cameras were built of depleted uranium to achieve a desired level of resolution and sensitivity. All the cameras have been used successfully to examine irradiated fuel pins nondestructively, and are capable of demonstrating damage, swelling, and cracking in fuel rods. These cameras are being used at both the Component Development Hot Cell at Atomics International, and in a hot-cell at the Hallam Nuclear Power Facility. (auth)

6155 EQUIPMENT FOR VIEWING AND PHOTOGRAPHING WITH THE REMOTE-CONTROL STEREO-ZOOM MICROSCOPE. J. H. Bowling and K. L. Rupp (Westinghouse Electric Corp., West Mifflin, Penna.). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 387-90.

The Remote Control Stereo-Zoom Microscope is designed specifically for remote visual examination and 35 mm photography of radioactive materials. To move the samples into a position where they can be handled with the master

slave manipulators, an elevating table was constructed. On top of the elevating table is a focusing table which provides the necessary motion translation for focusing and locating the samples. To provide adequate illumination, a lighting system has been designed which incorporates four individually controlled 200-watt Quartzline lamps plus a vertical illuminator coupled with a 150-watt air cooled projection type lamp. To protect the microscope lenses mounting system, the lights are mounted on a water cooled heat exchanger. Also described is the control box and methods for mounting a 35 mm reflex camera, a Speed Graphic camera, and a Polaroid camera as adjuncts to the 35 mm stereo camera are described. (D.L.C.)

6156 PLASMA OSCILLATIONS IN TRIODES WITH POSITIVE GRID. Gh. Cosma (Univ. of Bucharest). Rev. Roumaine Phys., 9: 163-80(1964). (In French)

In view of the determinations of the wavelengths of the waves generated by various triodes having positive grids, an attempt is made to establish the influence of the gas in the tube upon the oscillations produced. The dependence of the oscillations on the electrode geometry, grid potential, space charge, gas pressure, degree of ionization, and the nature of the gas becomes quite evident if it is considered that the phenomena are produced by electronic oscillations of the plasma in the tube. (tr-auth)

6157 30-40 MEGAWATTS RF LINE PULSE GENERATOR. Alfredo Lietti (Laboratorie de Recherches sur la Physique des Plasmas, Lausanne, Switzerland). Rev. Sci. Instr., 36: 13-15(Jan. 1965).

A generator consisting essentially of a lumped-element transmission line is described. The generator delivers 10 periods of 30 Mw at 1.5 Mc to a 10-ohm load or 40 Mw at 2 Mc. The technical feasibility of producing hundreds of megawatts for a longer time is considered. (D.C.W.)

6158 APPARATUS FOR NUCLEAR ORIENTATION BY ADIABATIC DEMAGNETIZATION. J. Hess, B. Greenebaum, F. M. Pipkin, and W. Weyhmann (Harvard Univ., Cambridge, Mass.). Rev. Sci. Instr., 36: 21-8(Jan. 1965).

An apparatus is described for cooling an iron foil containing a radioactive impurity to a temperature in the range of 0.012 to 0.026°K by thermal contact with an adiabatically demagnetized chromium potassium alum salt pill. The purpose of the demagnetization is to orient the nuclei of the radioactive impurity. A superconducting solenoid is used to produce the high magnetic field required to remove the entropy from the chrome alum. The apparatus uses two helium Dewars—a large one which contains the superconducting magnet and a small one which contains the salt pill, the 1°K helium bath, and the radioactive sample. The salt pill is formed by pressing a mixture of chrome alum and Octoil S around 5000 0.076-mm-diam copper wires. The salt is supported by a graphite cylinder and helium exchange gas is used to establish heat contact between the salt and the 1°K helium bath. In one form of the apparatus the chrome alum salt and the sample are surrounded by a copper can which is cooled to 0.1°K by contact with a manganese ammonium sulfate salt pill located in the fringe field of the superconducting magnet. With the chrome alum pill alone, the sample temperature is 0.019 to 0.026°K; with the guarded salt pill the sample temperature is 0.012 to 0.016°K. (auth)

6159 RADIO-FREQUENCY ION SOURCE PRODUCING VIBRATIONALLY EXCITED H_3^+. E. S. Chambers (Univ. of California, Livermore). Rev. Sci. Instr., 36: 41-4(Jan. 1965). (UCRL-12015)

An r-f ion source is described by which vibrationally excited H_3^+ ions were produced. The vibrational excitation of the ions was indicated by an abnormally high cross section for dissociation to H_2^+ and a high secondary electron yield on copper–beryllium. (D.C.W.)

6160 STROBOSCOPIC SHUTTER FOR VISUALLY STUDYING PLASMA OSCILLATIONS. I. Alexeff, W. D. Jones, and R. V. Neidigh (Oak Ridge National Lab., Tenn.). Rev. Sci. Instr., 36: 44-7(Jan. 1965). (ORNL-P-253)

A device is described by which periodic fluctuations in the light output of a plasma in the frequency range 10^3 to 10^6 cps can be stroboscopically stopped and studied. The use of the device in a study of moving striations is discussed. (D.C.W.)

6161 SINGLE-CRYSTAL FILTERS FOR ATTENUATING EPITHERMAL NEUTRONS AND GAMMA RAYS IN REACTOR BEAMS. R. M. Rustad (Columbia Univ., New York and Brookhaven National Lab., Upton, N. Y.), J. Als-Nielsen, A. Bahnsen, C. J. Christensen, and A. Nielsen. Rev. Sci. Instr., 36: 48-54(Jan. 1965). (BNL-8361)

The total neutron cross sections of representative, single-crystal samples of bismuth and quartz were measured at room and liquid nitrogen temperatures over the neutron energy range of 0.0007 to 2.0 ev to obtain data for the design of single-crystal filters for attenuating fast neutrons and gamma rays in reactor beams. The epithermal neutron and gamma transmissions of these crystals, calculated from cross sections given in various compilations, are presented graphically. From this information, filters composed of one or both crystals may be constructed to optimize beam characteristics for low-energy neutron experiments. The design and performance of the 32-cm bismuth, single-crystal filter at the Danish DR-3 reactor are described. The average thermal transmission of a typical reactor beam through this filter is 16%. In the wavelength region from 5 to 15 Å, the transmission is 72%. Neutron intensity in the resonant energy region is attenuated by a factor of 5000, and gamma rays of all energies by more than 5×10^5. The filter improved the Cd ratio of the reactor beam by a factor of 800. (auth)

6162 CHEMISORPTION DETECTOR FOR HYDROGEN. Melvin M. Eisenstadt and Stuart A. Hoenig (Univ. of Arizona, Tucson). Rev. Sci. Instr., 36: 66-8(Jan. 1965).

A chemisorption detector is described, which is based on the change in the work function of a palladium filament due to hydrogen chemisorption. The detector is effective over the pressure range from 10^{-5} to 10^{-8} torr. It responds strongly to O_2 and weakly to N_2. (D.C.W.)

6163 SUPERCONDUCTING SUSPENSION FOR A SENSITIVE ACCELEROMETER. P. K. Chapman and S. Ezekiel (Massachusetts Inst. of Tech., Cambridge). Rev. Sci. Instr., 36: 96(Jan. 1965).

A system is described in which a small magnet is suspended within a copper tube encased in a superconducting niobium cylinder, which is immersed in liquid helium. (D.C.W.)

6164 FOURIER ANALYZER FOR SPACE HARMONICS. K. Bol and K. Prelec (Princeton Univ., N. J.). Rev. Sci. Instr., 36: 98-9(Jan. 1965).

A circuit is described with which time-dependent Fourier amplitudes of spatially-extended disturbances can be obtained. (D.C.W.)

6165 AUTOMATIC RECORDING McLEOD GAUGE. Paul A. Faeth (Lewis Research Center, Cleveland). Rev. Sci. Instr., 36: 106-7(Jan. 1965).

A modified McLeod gauge is described with which pressures can be recorded automatically. (D.C.W.)

6166 A PENNING ION SOURCE FOR MASS SPECTROMETERS. Hans Boehm and Karl Georg Guenther (Siemens Schuckertwerke AG, Erlangen, Ger.). Z. Angew. Phys., 17: 553-7(1964). (In German)

A modified Penning ion source is described, which is applicable with technical mass spectrometers of the type with electric mass filters. An exact analysis of the characteristics, especially the ion current–pressure properties and the energy distribution of the ion beam, let it be recognized through which measures the critical values necessary for joining to a mass filter can be fulfilled. If the zero point were held sufficiently constant, a detection sensitivity of 10^{-9} torr for a resolution power of $m/\Delta m = 50$ to 100 could be achieved. The upper pressure limits lay between 10^{-4} and 10^{-3} torr. The ion source was unusually strong and its characteristics not damaged very much by

the presence of corrosive gases and air penetrations. (tr-auth)

6167 MODERNIZATION OF THE COMMERCIAL RADIOSPECTROMETER Re-1301 (EPR-2). V. B. Golubev (Moscow State Univ.). Zh. Fiz. Khim., 38: 2320-3(Sept. 1964). (In Russian)

A description is given of changes in the scheme and of some ancillary parts of a commercial radiospectrometer for EPR measurements, which increase its resolution. The new scheme involves recording the signal with low frequency modulation of the magnetic field. Operation of the instrument is simplified as is calculation of the spectrum parameters. A circuit is also described for continuous recording of reaction kinetics. (auth)

6168 QUADRUPOLE MASS SPECTROMETER FOR ATMOSPHERIC STUDIES IN THE 50- TO 90-KILOMETER RANGE. Wilson M. Brubaker, Norton W. Bell, and Frank B. Wiens (Bell and Howell Research Center, Pasadena, Calif.). 8p. (CONF-649-17)

From 12th Annual Conference on Mass Spectrometry and Applied Topics, Montreal, June 1964.

A quadrupole mass spectrometer system was designed for use on an atmosphere probing rocket (Nike-Cajun). Low pressure in the mass analyzer is maintained by a zeolite adsorption pump operating at liquid nitrogen temperature. The ionizing electron beam is concentrated at the aperture through which the sample is admitted. Thus the sensitivity of the source to incoming molecules is much higher than it is to the ambient molecules. Laboratory measurements with conventional pumps showed a differential sensitivity in excess of one hundred. A complete mass scan of the components below mass 45 is made every two seconds. The ion current amplifier compresses the range from 10^{-12} to 10^{-7} amperes into the 0- to 5-volt interval for telemetry. (auth)

6169 THE NEW HELIUM LEAK-DETECTOR. J. L. Chatel and J. Moreau. 18p. (CONF-642-11)

From Health Physics Society, Cincinnati, June 1964.

The three main elements of a new helium leak detector, Helitest 2002 (the vacuum circuit or system, the Type MC 10 analyzer cell, and the electronic circuitry) are described. The design of the detector is such as to be capable of facing any problems, however varied, of helium detection, both in industry and in the laboratory. Its maintenance is easy because of printed circuits used and the simple circuit arrangement of its analyzing cell. (P.C.H.)

6170 A NEW NORELCO SIMULTANEOUS SPECTROMETER FOR THE ANALYSIS OF THE LIGHT AND HEAVY ELEMENTS IN STATIC AND DYNAMIC SAMPLES. W. J. Pfoser and J. F. Croke (Applications Lab., Mount Vernon, N. Y.). Mount Vernon, N. Y. Philips Electronic Instruments, 1964, 13p. (CONF-546-2)

From Conference on Analytical Chemistry and Applied Spectroscopy, Pittsburgh, Mar. 1964.

A new automatic vacuum spectrometer was developed for the simultaneous analysis of as many as six elements above neon. It was developed primarily for industrial use, where large numbers of samples must be analyzed with a maximum of speed and accuracy. The instrument will accept powdered, liquid, and solid samples. Typical times of analysis for the determination of up to six elements in powdered sinters, slags, cements, and cement raw mix samples are in the order of 1 min. The analysis time is made possible by high intensity levels of characteristic radiation from the specimen, coupled with a unique mode of sample presentation that permits the introduction of specimens to the analyzing position of the instrument while maintaining a continuous operating vacuum of less than 200 μ. (P.C.H.)

6171 APPARATUS FOR THE SIMULTANEOUS OBSERVATION OF ELECTRICAL CONDUCTIVITY AND GAS DIFFUSION IN CRYSTALS. P. P. Pronko and H. R. Krouse (Univ. of Alberta, Edmonton). 11p. (CONF-649-8)

From 12th Annual Conference on Mass Spectrometry and Applied Topics, Montreal, June 1964.

An experimental approach to the simultaneous measurement of gas diffusion and electrical conductivity in solids is presented. Although the method can be applied to any solid, attention is directed toward ionic conductivity and diffusion of ^{40}Ar in dielectric materials. The purpose is to determine the mechanisms of atomic movement for various temperature ranges. Equations that predict the flux time curve are included along with a diagram of the diffusion-conductivity cell. It was found that the conductivity increases with temperature and tends to stabilize as the temperature comes to a constant value. The procedure is indicative of a semiconduction process. It seemed possible that in the neighborhood of 436°C the diffusion and conduction are dominantly vacancy-migration processes corresponding to volume diffusion. For higher temperatures, in the neighborhood of 500°C and above, an entirely different effect was observed. Here the conductivity and ^{40}Ar flux have the same sort of time dependence. They both decay characteristically with time. (P.C.H.)

6172 TIME BEHAVIOUR OF SELF-EXCITED FARADAY GENERATORS AND THEIR APPLICATION IN OSCILLATION GENERATORS. H. Burkhardt (Technische Hochschule, Stuttgart). 15p. (CONF-640701-28)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The time behavior of self-excited Faraday generators was analyzed as well as that of oscillation generators operating as undamped series oscillatory circuits. (D.C.W.)

6173 REGULATED POSITIVE POWER SUPPLY /Q-2517/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1081)

Two drawings are included for a power supply consisting of a 24-v card with a 100-ma rating. A 30-v a-c source must be used with the 3 × 5 in. card. The supply rectifies, filters, and regulates monitoring type instruments and is used with instruments not requiring close regulation or temperature compensation. (P.C.H.)

6174 TURBINE FLOW METER /Q-1718/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1145)

The turbine-type meter is used to measure the flow of liquid metals or fused salt at high temperatures. The device requires little maintenance and is only slightly dependent upon temperature over its usable range to 1500°F. No external piping is needed. (P.C.H.)

6175 IMPROVEMENTS IN OR RELATING TO A DEVICE FOR MEASURING AND RECORDING PULSE FREQUENCY. (to TESLA, Narodni Podnik). British Patent 967,367. Aug. 19, 1964. Priority date June 10, 1960, Czechoslovakia.

In the apparatus described, pulses are supplied to a digital pulse counter, which is so arranged that it produces a mark on a record sheet at the income of the K-th pulse. The mark is made with a recording device moving across the record sheet according to a law $x = \phi(t)$, where t denotes time and x denotes the distance of the recording device from a reference point on the track of the recording device, so that the coordinate x_f of a mark made on the record sheet at the arrival of the K-th pulse is $x_f = \phi(K/f)$ and is indicative of the frequency f. At a predetermined position of the recording device the pulse counter may be reset to zero and switched over in such a manner that it produces a mark at the arrival of the K′-th pulse, where K′ is a predetermined fraction of K selected to enable two ranges of frequencies to be recorded on different scales. After resetting of the pulse counter to zero, the movement of the recording device is detained for a period to avoid a gap between the two scales. If the device is provided with more than one recording tool, it may be used for simultaneous measuring and recording of pulse frequencies arriving from two or more sources. (A.G.W.)

6176 ION SOURCE. (to High Voltage Engineering Corp.). British Patent 971,770. Oct. 7, 1964. Priority date Dec. 11, 1961, United States.

An ion source for producing a well collimated high-density ion beam includes an intermediate electrode containing an electron-emitting filament positioned in an ionization chamber close to an anode with an aperture. The anode separates the ionization chamber from a beam-forming chamber containing an extractor electrode and focusing means. A plasma control member positioned between the anode and the extractor electrode has an aperture large with respect to the anode aperture and axially aligned with the anode aperture. The aperture in the anode is small enough to restrict gas flow from the ionization chamber to the beam-focusing chamber. The plasma control member is co-extensive with but spaced apart from the anode to provide a space between the anode and the plasma control member for radial expansion of the plasma. The ion source is adapted to deliver a directed ion beam having a current density of >500 ma/cm^2. (A.G.W.)

6177 IMPROVEMENTS IN OR RELATING TO SPECTROMETERS FOR PULSE ANALYSIS. Georges Fraysse, Georges Mirat, Paul Mirat, and Yves Pichoff (to Commissariat à l'Energie Atomique). British Patent 971,941. Oct. 7, 1964. Priority date Oct. 28, 1959, France.

A pulse-amplitude analyzing spectroscope comprises an image-retaining cathode ray tube having a memory or charge storage electrode disposed between the fluorescent screen and the horizontal and vertical beam deflection means of the tube. The memory electrode is arranged to accumulate a pattern of local electrical charges due to successive impingements upon it of a writing electron beam following a plurality of operations due to successive pulses to be analyzed. The horizontal beam deflection plates of the tube are connected to a circuit arranged to deliver for each input pulse a difference of potential of a value proportional to the amplitude of the pulse and of constant duration. The vertical deflection plates of the tube are connected to a sweeping circuit for delivering a beam deflection potential waveform of predetermined form. The control electrode of a writing beam electrode system of the tube is arranged to be supplied with an unblocking pulse synchronized with each of the input pulses, and a separate reading electron beam system is provided for bombarding the memory electrode after a plurality of pulses to be analyzed have been received so as to display the accumulated charges of the memory electrode on the fluorescent screen. (A.G.W.)

6178 A SOURCE OF IONS. (to Siemens-Schuckertwerke AG). British Patent 972,191. Oct. 7, 1964. Priority date Mar. 8, 1960, Germany.

A cold cathode ion source based on the Penning oscillating electron principle includes a tubular anode, an ion extraction channel substantially coaxial with the anode, means for providing a magnetic field within the anode and parallel to its axis, and at least one rod-shaped cathode member extending within the anode. The axis of each cathode member is parallel to the axis of the anode and its mean width is small in relation to the mean diameter of the anode. The rod-shaped cathode member terminates at a distance in front of the upstream end of the ion extraction channel about equal to the mean width of the rod. Two other cathode faces are located respectively opposite the two ends of the anode. The ion source is especially suitable and intended for electric mass filters. (A.G.W.)

6179 SEGMENTAL TIME REVERSAL DEVICE. Hugo L. Libby and James T. Russell (to U. S. Atomic Energy Commission). U. S. Patent 3,160,817. Dec. 8, 1964.

A device was designed for segmentally reversing in time a periodic signal. The device comprises a balanced electrical bridge having four impedance arms. One of the impedance arms is a transmission line having a plurality of capacitor-inductor sections. The input to the bridge is taken across the transmission line and an adjacent arm of the bridge. The output of the bridge is taken across the transmission line and the other adjacent arm of the bridge. The periodic signal is applied to the input of the bridge to generate a periodic traveling wave on the transmission line and means are provided responsive to the periodic traveling wave for charging the capacitors of the sections of the transmission line, so that a traveling wave is propagated on the transmission line in reverse to the periodic traveling wave. The reverse traveling wave appears at the output of the bridge in time reversal with respect to the applied signal. (AEC)

Radiation Detection

Refer also to abstract 5739.

6180 (AAEC/TM-268) PHOTOPEAK EFFICIENCIES FOR NaI(Tl) CRYSTALS FOR POINT AND EXTENDED SOURCES. R. J. Finn (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Oct. 1964. 20p. Dep.(mn).

This report gives a series of calibration curves which relate the photopeak counting rate in NaI(Tl) crystals to the number of photons being emitted by the radioactive source. The curves cover the energy range of 0.3 to 1.5 Mev for 8-in. dia. × 4 in., 5-in. dia. × 4 in., and 3-in. dia. × 3 in. NaI(Tl) crystals. (auth)

6181 (AERE-R-4727) A PROPORTIONAL GAS FLOW COUNTER FOR ROUTINE α- AND β-COUNTING—THE "SUGARMAN" COUNTER. PART I. DEVELOPMENT, CONSTRUCTION AND OPERATION. J. G. Cuninghame and G. P. Kitt. PART II. SELF-ABSORPTION AND BAYHURST CURVES. J. G. Cuninghame, M. P. Edwards, J. A. B. Goodall, G. P. Kitt, C. B. Webster, and H. H. Willis (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Oct. 1964. 45p. Dep.; $1.40(BIS), 7s.(HMSO).

The development and operation of an end-window proportional gas flow counter suitable for α and β counting is described. The counter has an efficiency of ~40% for a hard β emitter and operates with a β background of ~0.8 counts per minute with a suitable anti-coincidence sheath. Experimental data applicable to all counters of this type and to low background β-counting in general are included. Data needed for the plotting of self-absorption curves for 31 commonly used β-emitting nuclides are given, together with Bayhurst counter efficiency curves derived from them. (auth)

6182 (BNL-8633) THE ENERGY LOSS BY CHARGED PARTICLES IN SILICON AS A FUNCTION OF TRACK ORIENTATION. H. E. Wegner, C. Erginsoy (Brookhaven National Lab., Upton, N. Y.); and W. M. Gibson (Bell Telephone Labs., Inc., Murray Hill, N. J.). [1964]. Contract AT-30-2-GEN-16. 12p. (CONF-799-6). Dep.(mn); $1.00 (cy), 1(mn) OTS.

From 11th Annual Nuclear Science Symposium, Philadelphia, Oct. 1964.

It is important to know the orientation of the crystal axis of silicon semiconductor detectors when they are used for the detection of energetic charged particles in stacked arrays and the particles are expected to traverse all of the detectors. It has been observed that particles that pass through the crystal along the directions of crystal planes or axes lose less energy than those in other directions. This anomalous energy loss spoils the response characteristics of the detector. Various experiments have demonstrated that the penetrating particles tend to move along crystal planes or axes by a process of correlated multiple-coulomb scattering. The experimental evidence for these anomalous characteristics will be reviewed and the degrading effects on the discrimination ability of mass-discrimination detector-systems will be shown. Mass distribution curves were taken for protons, deuterons, and tritons, as well as ^{3}He and alpha particles in the 20 to 40 Mev region with a thin silicon ΔE detector oriented with the (111), (110), and other axis parallel to the penetrating particle direction. The mass separation is appreciably improved when the crystal is oriented so that the direction of the penetrating particles is well away from any of the major crystal planes or axes. (auth)

6183 (IA-981) FACILITY FOR CALIBRATING RADIATION SURVEY METERS. Jan Strop (Israel. Atomic Energy Commission. Soreq Research Establishment, Rehovoth). Aug. 1964. 7p. Dep.(mn).

A calibration facility is described in which γ-ray, β-ray, and thermal- and fast-neutron survey meters are calibrated. This facility ensures good geometry and high safety conditions. (auth)

6184 (IDO-17022) PRELIMINARY STUDIES FOR A CURVED-CRYSTAL NEUTRON SPECTROMETER. R. R. Spencer, L. G. Miller, and M. S. Moore (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Oct. 1964. Contract AT(10-1)-205. 24p. Dep.; $2.00(OTS).

Preliminary studies of the diffraction properties of both plane and curved crystals of various materials have been carried out, pursuant to their application as monochromators in a curved-crystal neutron spectrometer. Most promising of the crystals studied were a flat germanium crystal, a curved NaCl crystal, and a curved beryllium crystal. (auth)

6185 (IDO-17043) DETECTOR EFFICIENCY OF CONTINUOUS AIR MONITOR HAVING THE FILTER COAXIAL WITH THE DETECTOR. E. A. King (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Oct. 1964. Contract AT(10-1)-205. 26p. Dep.; $2.00(OTS).

The knowledge of the detector efficiency of a continuous air monitor having the filter coaxial with the detector has been related to just ^{89}Sr, ^{90}Y, and radon, thoron daughter products in the past. A list is presented of directly determined detector efficiencies for several other radionuclides. A procedure is also given which can be used to determine the detector efficiency for additional radionuclides. This procedure is used to extend the list of detector efficiencies versus radionuclides. (auth)

6186 (JUL-200-PP) EIN TROCHOIDSPEKTROMETER ZUR MESSUNG DER ENERGIEVERTEILUNG VON IONEN IN PLASMEN. (A Trochoid Spectrometer for Measurement of Energy Distribution of Ions in Plasma). C. Bastian (Kernforschungsanlage. Institüt fur Plasmaphysik, Jülich, Germany). Oct. 1964. 20p. Dep.(mn).

An ion spectrometer for plasma physics is described. The analyzing structure combines crossed uniform electric and magnetic fields which provide a mass focusing and an energy selection. For a given mass of the ions, four stigmatic images of the inlet diaphragm appear on the spectrogram. They correspond to ions of four definite energies which are simultaneously recorded. A spectrometer of this type is designed for protons ranging from 500 to 25,000 ev. The protons can be recorded either on a photographic plate, by four Faraday cups, or by four scintillations counters. (auth)

6187 LITHIUM-DRIFTED SILICON JUNCTION DETECTORS. Sakae Nishiu, Takashi Nakakado, Yasuyuki Nakayama, and Sakae Shimizu. Bull. Inst. Chem. Res., Kyoto Univ., 42: 319-37(Sept. 1964).

Details of the procedure for preparation of Li-ion-drifted silicon detectors are described. Various characteristics of the detectors prepared were examined by use of nuclear radiations including electrons, alpha particles, and gamma rays. Special attention was given to the detector response for incident electrons using conversion electrons from some nuclides and mono-energetic electrons obtained by a beta spectrometer at room and liquid-nitrogen temperatures. The p-i-n junction detectors prepared exhibited their extreme usefulness for measuring beta rays from very weak sources. It may be emphasized that in some aspects the use of the semiconductor detector of such a type for beta spectroscopy seems to be advantageous compared with the usual magnetic spectrometer, although some essential properties remain to be improved. For gamma spectroscopy the detector showed its usefulness when it was used at lower temperature, especially by its excellent energy selection for incident photons compared with the crystal scintillation detector. The radiation damage and spontaneous deterioration of the detector were also studied. As a cause responsible for the deterioration, the redistribution of lithium atoms in silicon with the lapse of time after the Li-ion drifting process was examined in some details. Measurements of nuclear radiations performed with the p-i-n junction detector are also discussed. (P.C.H.)

6188 ASPIRATORY INSTALLATION FOR DETERMINING THE CONCENTRATION OF LONG-LIVED RADIOACTIVE SUBSTANCES IN THE ATMOSPHERE. V. P. Rublevskii. Gigiena i Sanit., No. 9, 60-3(Sept. 1964). (In Russian)

The apparatus proposed has a high capacity (350 to 400 m^3/hr) and is intended for long continuous operation. It may be used for stationary as well as in-flight atmospheric studies. The ventilator, filter, voltage-supply system, protective casing, and exhaust system are described, and the operating conditions of the apparatus are discussed. Concentrations of radioactive material in the atmosphere to 10^{-16} or 10^{-17} C/l may be measured. (M.J.T.)

6189 ON THE DETERMINATION OF DISTORTION IN NUCLEAR EMULSIONS. Prem K. Aditya (Indian Inst. of Tech., New Delhi). Indian J. Phys., 38: 326-30(June 1964).

A method is described by which extensive distortion present in emulsions can be measured and its influence on multiple Coulomb scattering measurements eliminated. (auth)

6190 A RADIOGRAPHIC INSPECTION DEVICE USING SOLID-STATE p-i-n JUNCTION DETECTORS. N. A. Baily, G. D. Robertson, and F. W. Cleary (Hughes Research Labs., Malibu, Calif.). Intern. J. Appl. Radiation Isotopes, 15: 523-8(Sept. 1964).

The use of p-i-n junctions as the sensitive elements of dynamic radiographic inspection systems was investigated. The feasibility of doing this was established for both steady-state and pulsed radiation sources. The resolution obtained using a differential system was excellent for beam intensities delivering an exposure of at least 2 mr at the surface of the detectors in a time period short compared to the decay characteristics of the circuitry. At this radiation level, signal-to-noise ratios of approximately 15:1 without amplification were obtained for defects representing 2% change in flux level. Scanning rates of 6 to 12 in./min should be possible. Large area scanning may be accomplished through the use of mosaics made up of a large number of junctions. (auth)

6191 SPHERICAL GEIGER COUNTERS FOR γ-RAY FLUX MEASUREMENTS. A. W. B. Jacob (Univ. of Dublin). Intern. J. Appl. Radiation Isotopes, 15: 553(Sept. 1964).

A spherical Geiger counter was designed for measuring gamma flux from ^{137}Cs irradiator. Its response to gamma rays was constant to $\pm 2\frac{1}{2}\%$ over an angle of 340°. (M.C.G.)

6192 DEAD-TIME CORRECTIONS IN 4π β-γ COINCIDENCE COUNTING, WHERE SEVERAL γ-CHANNELS ARE EMPLOYED. T. B. Ryves and J. C. Robertson (National Physical Lab., Teddington, Middx., Eng.). Intern. J. Appl. Radiation Isotopes, 15: 555-7(Sept. 1964).

It was found that if several separate identical gamma channels are used in a 4π β-γ coincidence counting system, there are two conditions necessary to make the absolute disintegration rate independent of the number of gamma channels used: when the time the mixing circuit is paralyzed is greater or equal to the dead time of the channels or when it is greater or equal to the mixing pulse plus resolving time. If only a single gamma channel is employed the single necessary condition is either the time, the mixing circuit, or the dead time of the channels is paralyzed is greater or equal to the mixing pulse plus resolving time. (M.C.G.)

6193 CALCULATED EFFICIENCIES OF NaI(Tl) SCINTILLATION CRYSTALS FOR AQUEOUS CYLINDRICAL SOURCES. M. L. Verheijke (Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). Intern. J. Appl. Radiation Isotopes, 15: 559-63(Sept. 1964).

Efficiencies of NaI(Tl) scintillation crystals were calculated for aqueous cylindrical gamma sources. Equations and tables and graphs of results of computer calculations are presented. (M.C.G.)

6194 CALIBRATION FACTORS FOR THE TYPE 1383A β-γ IONIZATION CHAMBER. J. W. G. Dale and A. Williams (National Physical Lab., Teddington, Middx., Eng.). Intern. J. Appl. Radiation Isotopes, 15: 567-8 (Sept. 1964).

Calibration factors for a 1383A ionization chamber are presented in tabular form for ^{24}Na, ^{32}P, ^{42}K, ^{51}Cr, ^{54}Mn, ^{56}Mn, ^{59}Fe, ^{60}Co, ^{82}Bi, ^{90}Y, ^{95}Nb, ^{131}I, ^{137}Cs, ^{198}Au, ^{204}Tl, and ^{226}Ra. (M.C.G.)

6195 CHARACTERISTICS OF SPECTROMETER WITH PULSE SUMMATION. V. R. Burmistrov and V. A. Didorenko. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 52-7(1963). (In Russian)

Descriptions are given of a Compton scintillation gamma spectrometer for measuring ~1-Mev γ emissions from slow neutron capture. Effects of crystal size, relative crystal distribution, degree of γ collimation, and other variables on efficiency, curve, shape, and energy resolution are investigated. (R.V.J.)

6196 BETA-SPECTROSCOPY OF LOW LEVEL SAMPLES BY A COINCIDENCE TYPE SCINTILLATION SPECTROMETER. Eiichi Tanaka, Toshiyuki Hiramoto, and Takashi Maruyama (National Inst. of Radiological Sciences, Chiba-shi, Japan). J. Nucl. Sci. Technol. (Tokyo), 1: 305-10(Nov. 1964).

A beta spectrometer is described in which a disk-shaped G-M tube with thin film windows on both flat faces is located with the top window in contact with a plastic scintillator. Spectra demonstrating the characteristics of the detector are included, together with estimates of minimum detectable amounts of activity. Measurements of known isotopes and identifications of isotopes are also discussed. (D.C.W.)

6197 SILICON SURFACE BARRIER DETECTOR. Seiichiro Gotoh and Zinzaburo Takagi (Nippon Atomic Industry Group Co., Japan). J. Nucl. Sci. Technol. (Tokyo), 1: 311-15(Nov. 1964).

A method was established for producing silicon surface-barrier detectors with an energy resolution of 0.7% for 5.3-Mev alpha particles and with long-term stability. The fabricated detector was found to have a depletion layer as thick as 200 μ and a surface layer with an energy loss of less than 15 kev for 5.3-Mev alpha particles. The detector was found to be stable for at least 2 to 3 months. (auth)

6198 EFFECTS OF GEOMETRY IN A PARTICLE DETECTOR UTILIZING SCINTILLATIONS IN A GAS. J. Teyssier, D. Blanc, L. Commanay, and A. Godeau (Faculte des Sciences, Toulouse). J. Radiol. Electrol. Med. Nucl., 45: 477-8(Aug.-Sept. 1964). (In French)

The effects of geometry in a scintillation detector filled with pure xenon were studied. The scintillation chamber was made of stainless steel and the walls were covered with magnesium oxide. The xenon was excited with α particles emitted by a collimated source of ^{239}Pu. The effects of the variation of the distance between source and window were determined at constant pressure. The optimum source-window distance was slightly less than the path of the α particles at 760 torr and almost corresponded to the position of the ionization maximum created by α particles. With variation of the pressure between 912 and 1250 torr, the pulse height was a decreasing function of the pressure with a fixed source. If source-window distance is changed at each pressure to correspond to the best geometry conditions, the pulse height remains constant. (J.S.R.)

6199 ERRORS OF NEUTRON-FLUX MEASUREMENTS DUE TO THE INCOMPLETE COMPENSATION OF GAMMA-COMPENSATED IONIZATION CHAMBERS. W. Frey (VEB Vakutronik, Dresden). Kernenergie, 7: 716-20(Oct. 1964). (In German)

The neutron flux interval, in which the measuring ranges of fission and B chambers giving nearly the same measuring values overlap, is determined by the degree of gamma-ray compensation in the B ionization chamber. The residual current occurring for incomplete gamma-ray compensation was measured by means of double chambers insensitive to neutrons. From these values the accuracy of flux measurements in reactor startup was determined. Possible modes of operation of the gamma-compensated neutron ionization chamber are discussed. The inherent stability of the system chamber/automatic control/reactor is indicated to be possible. (auth)

6200 X-RAY EMISSION ANALYSIS BY PULSE-HEIGHT ANALYSIS. Hiroshi Imamura, Kaoru Uchida, and Hiroshi Tominaga (Ube Industries, Ltd., Japan). Radioisotopes (Tokyo), 13: 355-61(Sept. 1964). (In Japanese)

As an advantageous example of the application of x-ray emission analysis using radioactive sources, the rapid analysis of cement raw mixture was investigated. Problems concerning the pulse-height analysis for non-dispersive x-ray spectrometry are discussed; first, spectrometry of adjacent elements, then, stabilization of the spectrometer. In the former, pulse-height channel setting technique utilizing the cancel effect was tried. An example is the case when only the content of lower-Z-element B increases, the count-decrease of higher-Z-element A is canceled by the count-increase of B. This effect appears between two adjacent elements where x-rays of A are resonantly absorbed by B. Thus, by the channel where this effect is valid, content of A can be easily determined independently of B, when Z difference of both elements is adequately large, or when excitation-detection-efficiency of A is higher sufficiently than B. In fact SiO_2 was analyzed without any effect by MgO or Al_2O_3 in cement raw mix. In the second problem it was proved that level stability of a single channel pulse height analyzer is fairly good and the most probable variation in pulse height arises out of a proportional counter (gas amplification in the counter varies sensitively by temperature or pressure of the gas). So the detecting methods of pulse height variation using pulse height analyzer were studied. As the remarkable and symmetrical peak was produced by calcium in the spectrum of the example, fortunately, the vibrating channel was set at this peak level for the detection of pulse height variation. Feed back control of pulse height was carried out with the improved d-c amplifier circuit (feed back amplifier as a controller). Because of the lack of the amplifier gain, resetting operation by addition of integration was not effective. Stabilization factor was about 33 using the peak of Ca (half width = 26%, total count rate = 170 cps). (P.C.H.)

6201 STATISTICS OF SINGLE-ELECTRON MULTIPLICATION. G. C. Baldwin and S. I. Friedman (General Electric Co., Schenectady, N. Y.). Rev. Sci. Instr., 36: 16-18(Jan. 1965).

Measurements of the pulse-height distribution from electron multipliers excited by single electrons are interpreted in terms of the Poisson statistics to give the secondary emission coefficient and detection efficiency. It is shown that silver-magnesium dynodes are characterized by a distribution of local values of the secondary emission coefficient. (auth)

6202 SCANNING PHOTOMULTIPLIER FOR STUDYING CHEMILUMINESCENT REACTIONS IN FLOW SYSTEMS. Eric R. Allen, Frank E. Grahek, and Richard D. Cadle (National Center for Atmospheric Research, Boulder, Colo.). Rev. Sci. Instr., 36: 35-7(Jan. 1965).

A continuous vertical scanning photosensitive device is described which is capable of monitoring the radiation intensity of chemiluminescent reactions in cylindrical flow reactors. The output from the photomultiplier is fed to a conventional millivolt recorder to obtain a plot of intensity as a function of time. This enables calculations to be made of concentrations and rate constants of reaction for the species taking part in the chemiluminescent reaction, if the reactions occurring are well understood. (auth)

6203 OPERATING CHARACTERISTICS OF A COMMERCIAL RESISTANCE-STRIP MAGNETIC ELECTRON

MULTIPLIER. W. W. Hung, Jr. (Air Force Cambridge Research Labs., Bedford, Mass.), K. E. McGee and M. J. Kennedy. Rev. Sci. Instr., 36: 110-11(Jan. 1965).

The operating characteristics of a Bendix model MDN-105 electron multiplier used as the particle detector in a time-of-flight mass spectrometer were investigated. The variations of the output current with the Z-plate voltage are discussed in detail. (D.C.W.)

6204 DOSIMETRIC INSTRUMENTS. A. Teplov. Voennye Znaniya, No. 7, 28-9(1964).

Methods and means for detection of radioactive contamination are discussed. After a brief explanation of the types of radiation with which a civil defense organization will have to cope, descriptions are given of four basic dosimetric instruments: roentgenometers, radiometers, dosimeters, and radioactivity indicators. It was concluded that some instruments used in the national economy and industry can fulfill the needs of civil defense. (TCO)

6205 SPECTRAL CHARACTERISTICS OF SEMICONDUCTOR DETECTORS FOR PULSED X RADIATION. A. A. Egorov, A. A. Lukashov, and E. V. Nitochkina. Zh. Tekhn. Fiz., 34: 2038-43(Nov. 1964). (In Russian)

Some characteristics of Ge and Si semiconductor radiation detectors for x radiation pulses on the order of 10^{-7} sec were studied. The short-circuit current of the detectors under these conditions is proportional to the radiation intensity, and the spectral characteristic in the quantum energy range from 30 to 600 kev is proportional to $\mu\varepsilon$. (tr-auth)

6206 SAMPLE CURETTE FOR WORK WITH CYLINDRICAL BETA AND GAMMA RAY COUNTERS. M. P. Bel'dy. p.157-8 of "Novye Mashiny i Pribory Dlya Ispytaniya Metallovedenie. Sbornik Statey." Moscow, Metallurgizdat, 1963.

It is proposed that the external body of a curette of organic glass and an inner test tube of perchlorovinyl resin with a 15-20 mg/cm^2 wall, or even 5-10 mg/cm^2 wall, be used with small counter tubes. The external body of such a curette is turned from a solid bar or formed from a sheet of organic glass. The bottom is then glued to the body, forming a ring of the same organic glass. The perchlorovinyl resin test tube is then inserted into the hole of the body bottom, protruding 1 cm through the hole centered and glued to the body with dichloroethane. After drying, the protruding part of the test tube is cut off. The procedure for making the plastic test tube by dipping a glass test tube into a solution of perchlorovinyl powder in dichloroethane, drying the formed layer, and stripping the bag off the glass test tube is described in detail. The curette obtained is suitable for work with the STS-6 and AS-2 counters. The counter is mounted vertically for work with such a curette, the cathode grounded, and the positive charge applied from below. It has been recommended to select the gap λ between the walls of the beaker according to the expressions $\lambda_1 = 0.4\ (R/\rho)$ and $\lambda_2 = R/\rho$, where ρ is the density of the sample and R the practical path of beta particles; subscript 1 refers to curettes intended for work under conditions $0.2 < \rho\lambda < R$, and subscript 2 refers to curettes warranting a saturation layer. (TCO)

6207 THE CONTRIBUTION OF SPECTROMETER STABILIZATION TO THE UNSCRAMBLING OF MIXED GAMMA-RAY SCINTILLATION SPECTRA. R. A. Dudley (International Atomic Energy Agency, Vienna). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/64, 13p. (CONF-641001-26)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

By stabilization of a spectrometer system against gain and zero shifts of every origin, constancy of peak-channel numbers was achieved to a few hundredths of a channel out of 200 channels, and of resolution to better than 1% of peak width. Experimental data illustrating this stability and its contribution to the accuracy of unscrambling mixed spectra are presented. The errors were found to approach the theoretical limit set by counting statistical fluctuations alone. The special promise of such stabilization for the unscrambling of spectra from multi-detector systems is emphasized. (P.C.H.)

6208 PULSE LINE SPARK GAP II (Engineering Materials). (California. Univ., Berkeley. Lawrence Radiation Lab.). (CAPE-564)

Eight drawings are included for a spark gap contained in a pyrex housing 6 in. long. The housing is shaped so that the walls are at least $\frac{3}{8}$ in. thick but it is not cylindrical. The largest OD is $6\frac{1}{8}$ in. and the smallest ID is 4 in. The end plates are $7\frac{1}{2}$ in. in dia. The fixed electrode is a $\frac{1}{4}$-in. Cu rod $1\frac{3}{4}$ in. long contained in a $1\frac{1}{2}$-in. Cu tube $3\frac{1}{8}$ in. long and $\frac{5}{16}$ in. thick. The opening in the hemispherical end is $\frac{3}{8}$ in. wide. The adjustable tip is a $1\frac{1}{2}$-in. Cu rod $4\frac{3}{4}$ in. long with a hemispherical end. The spark gap is used in a pulse line. (P.C.H.)

6209 BF_3 PROPORTIONAL COUNTER FOR PORTABLE SURVEY INSTRUMENT /Q-2170/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1133)

The counter is used in health physics with a Thermal Neutron Survey Meter (see CAPE-745, Thermal Neutron Survey Meter). The Al counter tube is $6\frac{7}{16} \pm \frac{1}{16}$ in. long and is filled to 15 cm of Hg absolute pressure with 96% enriched $^{10}BF_3$. The counter is designed to be used at 1200 v and has a minimum plateau of 200 v with 3% or less slope per 100 v. (P.C.H.)

6210 GEIGER TUBE SURVEY PROBE /Q-2152/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1134)

The hooded, Geiger tube probe has an Al tube housing $7\frac{3}{4}$ in. long, 1 in. OD, and a 0.065-in. wall thickness. The cover is $4\frac{1}{4}$ in. long, $1\frac{1}{8}$ in. OD, and 0.058 in. thick. The tube is an Anton 105 G or an Amperex 90 NB. The Al tube holder is $2\frac{1}{16}$ in. long, 0.875 in. OD, and 0.783 in. ID. The tube socket is constructed of linen filled bakelite. It is 0.783 in. OD, 0.638 in. ID, and $\frac{7}{16}$ in. thick. (P.C.H.)

6211 NEUTRON MONITOR WITH OPTIONAL BURST DETECTOR /Q-2562/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1157)

Ten drawings are included for a transistorized, a-c powered monitor used for continuous measurement of fast and thermal neutron dose rates and for immediate critical incident occurrence warning. The instrument has a single range of 0 to 25 mrem/hr indicated by a calibrated panel meter. An alarm can be manually adjusted to sound the alarm at any value in the range. Monitor output can be fed to a strip chart to record dose rate. An optional fast burst alarm operates independently of the dose rate circuitry. The fast burst response sounds an alarm when neutron bursts of 20 μsec duration originate from critical incidents up to 200 ft from the detector. A polyethylene moderator surrounds the BF_3 detector to thermalize fast neutrons. The polyethylene is covered with a 0.025-in.-thick Cd sheet to lower cut-off limit to the thermal neutrons. (P.C.H.)

6212 ELECTROSTATIC HIGH ENERGY CHARGED PARTICLE SEPARATOR. N. I. Malashkevich. Russian Patent 163,683.

An electrostatic high energy charged particle separator is described. The distinguishing feature is electrical stability, simplification of manufacture, and utilization. The vacuum space with moving particles is separated from the metal electrodes, to which is applied a difference of potentials. The device features the exclusion of a high-voltage cable for connecting the high-voltage source to the separator. The electrodes, high-voltage leads, and high-voltage sources are placed in a single high-pressure vessel. (auth)

Radiation Effects

6213 (EURAEC-1113) SOLID-STATE NEUTRON DETECTOR. Quarterly Report No. 3, April 1–June 30,

1964. (Centre d'Étude de l'Énergie Nucléaire, Mol, Belgium). Work Performed under United States–Euratom Joint Research and Development Program. Contract 099-63-10-RDB. 13p. (R-2295) Dep.(mn); $1.00(cy), 1(mn) OTS.

A SiC diode, irradiated at 250°C, was lost because of failure of the irradiation facility. The results of some measurements before irradiation are given. After the construction of a new furnace, a first irradiation up to 1.2×10^{15} nvt of a second SiC diode was carried out at 250°C. The results do not show any annealing while the pulse height decreased by 25%. (auth)

6214 (HMI-B-28) MESSUNGEN DER STRAHLENRESISTENZ VON HALBLEITER-BAUELEMENTEN. (Measurements of Radiation Resistance of Semiconductor Elements). K. Zander (Hahn-Meitner-Institut für Kernforschung, Berlin). Nov. 1963. 154p. Dep.(mn).

A short introduction is presented to radiation damage in semiconductors. Changes in I-V-characteristics of diodes are described on the basis of irradiated pn-junction in low and high levels of carrier injections. The behavior of Zener-, photo-, and tunnel-diodes under radiation is discussed, too. Changes in I-V-characteristics, d-c-quantities and a-c-parameters of germanium and silicon transistors are demonstrated by many measuring curves. A special chapter is dedicated to problems of surface influences on the electrical behavior of semiconductor elements, especially on four-layer diodes. The behavior of controlled rectifiers and four-layer-diodes under radiation, as well as switching times of diodes and transistors after irradiation are examined. (auth)

ISOTOPE TECHNOLOGY

General

6215 (HW-83284) A COMPARISON OF THEORETICAL AND MEASURED DOSE RATES OF THORIUM AND THORIUM OXIDE. J. N. Morgan and L. G. Faust (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 15, 1964. Contract AT(45-1)-1350. 18p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The surface dose rate due to each isotope in the thorium chain was calculated. After corrections were made for the state of equilibrium of the material, agreement was found between theoretical and experimental values of surface dose rates. Thorium should not present a serious problem with respect to external personnel exposure. Formulas are presented, which give an approximate value for the time lapse since the most recent purification. Gamma and alpha energy spectra measurements for the metal and the oxide of thorium are presented. (auth)

6216 USE OF Kr^{85} LOADED ACTIVATED CHARCOAL IN X-RAY SOURCES. H. Schaefer (Institute fur Medizine und Biologie, Deutsche Akademie der Wissenschaften, Berlin). Kernenergie, 7: 724-6(Oct. 1964). (In German)

Activated charcoal was used in x ray sources on ^{85}Kr base for increasing the specific volume activity. By means of self-absorption measurements using ^{204}Tl loaded granular coal the limits of this method are discussed. (auth)

Industrial Applications

6217 (TEI-855) MEASUREMENT OF TURBINE DISCHARGE WITH RADIOISOTOPES. Bernard J. Frederick (Geological Survey, Washington, D. C.). Oct. 1964. 36p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Sixteen laboratory and field experiments were conducted to investigate the feasibility of determining turbine discharge using radioactive isotopes as tracers and dilution methods of computation. Discharge figures obtained from these few exploratory experiments compare favorably with figures obtained by other methods, but additional work is needed to establish whether or not the procedures suggested will result in an improved method of rating turbines. Possible advantages of radioisotopes over other tracers in ability to resist sorption or loss, amount of tracer required for a discharge measurement, and suitability for on-site determination of discharge lend support to the need for additional investigation. (auth)

6218 (TID-21199) RADIOACTIVE TRACERS IN MISCIBLE-PHASE PETROLEUM PRODUCTION OPERATIONS. F. E. Armstrong, W. D. Howell, and Gordon E. Fletcher (Bureau of Mines. Bartlesville Petroleum Research Center, Okla.). [1963]. Contract AT(49-11)-1964. 37p. Dep.; $2.00 OTS.

An investigation has been made to determine the utility of radioisotopes as tracers in the development of miscible-phase methods of petroleum recovery. Tritium was used in two field experiments to trace the flow of gasoline, of isopropanol, and of water. In one experiment, the relative vertical saturation of a producing formation with injected fluid was determined by analysis of liquids extracted from cores obtained from the formation during the test. In both field experiments, which are still in progress as of this date, considerable useful data were obtained. No major problems were encountered in actual tracer operations, although the synthesis and handling of large quantities of tagged hydrocarbons required special precaution to avoid contamination. It was concluded that the use of radioactive tracers, in particular tritium compounds, affords an opportunity to obtain otherwise unavailable data concerning the performance and efficiency of miscible-phase petroleum-recovery mechanisms. (auth)

6219 (JPRS-27558) SOVIET RESEARCH ON ANTIBIOTICS. Translated from Antibiotiki, 9: 926-32; 946-50 (Oct. 1964). 22p. (TT-64-51806). $1.00 (OTS).

Three articles on Soviet research in antibiotics are presented. Separate abstracts were prepared for two. The remaining article considers biochemical mechanisms of antibiotic action. (H.M.G.)

For abstracts of individual papers see: 6220 and 6221.

6220 (JPRS-27558(p.1-7)) RADIATION STERILIZATION OF PREPARATIONS OF THE TETRACYCLINE GROUP AND OF SOME OTHER ANTIBIOTICS. V. I. Pochapinskii (Pochapinskiy), et al. Translated from Antibiotiki, 9: 926-30(Oct. 1964).

Research in radiosterilization of hydrochloride salts of tetracycline and oxytetracycline, sodium salts of aureomycin, nystatincolimycin, and sulfate salts of mycerin and polymyxin is discussed. Results of experiments on sterilization of distilled water and containers are also presented. It was indicated that even in the case of mass inoculation of antibiotic preparations of the tetracycline series group and distilled water, as well as materials used for their packaging, an absorbed dose of ^{60}Co γ radiation of 2.5 million rad ensures their sterility. The antibiotics studied did not change either the specific activity peculiar to them following radiosterilization or their qualities with regard to chemotherapeutic and pharmaceutical properties. A slight deterioration of the crystals was observed in all the antibiotic preparations studied (except mycerin) following radiosterilization. Crystals of lyophilically dried mycerin sulfate were substantially changed. Glass vials became clouded but cleared up with time. Irradiated test tubes regained their former appearance after heating for 20 min at 150°. (H.M.G.)

6221 (JPRS-27558(p.8-12)) PENICILLINASE STERILIZATION WITH GAMMA-RADIATION OF RADIOACTIVE COBALT (Co^{60}). S. M. Chaykovskaya, et al. Translated from Antibiotiki, 9: 930-2(Oct. 1964).

Penicillinase samples obtained from two strains of Bacillus cereus were irradiated with ^{60}Co γ rays (1.5, 2.0, or 2.5 Mrad). The possibility of penicillinase sterilization with ^{60}Co γ radiation was established. It was determined that penicillinase may be sterilized in the form of a fermentation broth filtrate or an acetone powder in the final market package, and that the minimum sterilizing dose securing the penicillinase sterility is 2.5 million rad. The decrease in the activity level of various penicillinase samples sterilized by the radiation method was insignificant. (H.M.G.)

6222 GAMMA RADIATION ABSORPTION MEASUREMENT OF DENSITY AND GAS HOLD-UP IN A THREE-PHASE CATALYTIC REACTOR. R. Farley and D. J. Ray (D.S.I.R. Warren Spring Lab., Stevenage, Hertz, Eng.). Brit. Chem. Eng., 9: 830-2(Dec. 1964).

The use of gamma techniques for measuring the density and gas hold-up of a gas/liquid/solid dispersion within a medium pressure reactor at temperatures up to 300°C is described. The design and methods of calibration and operation are given, with typical results. It was concluded that this system should find application in the development and control of many types of chemical reactors. (auth)

6223 FIGHT WATER POLLUTION WITH RADIATION. Can. Chem. Process., 48: 81-3(Nov. 1964).

Gamma irradiation of sewage at certain dose rates substantially increased the rate of sedimentation and degraded alkyl benzene sulfonates. A review of preliminary investigations indicated that ^{60}Co and ^{137}Cs may be used as radiation sources to increase the treatment capacity of existing plants. Dose rates required and reaction mechanisms are discussed briefly. (F.S.A.)

6224 THE SANITARY SIGNIFICANCE OF COLON BACILLI IN WATER DISINFECTED WITH γ-RADIATIONS. V. A. Ryabchenko. Gigiena i Sanit., No. 9, 23-7(Sept. 1964). (In Russian)

Advantages of the method for disinfecting water with γ radiation over chlorination and ultraviolet irradiation are assessed. Data are presented on the disinfecting action of γ radiation on the colon-typhoid bacteria present in water in concentrations from 1000 to 1 million cells per litre water. For disinfecting water containing 1000 to 10,000 bacteria per litre, by means of γ radiations a dose of 40 to 50 thousand R is sufficient. When water is disinfected by means of γ radiations the colon bacilli retain their significance as a sanitary index. (auth)

Power Application

6225 (DP-939) RADIATION PROPERTIES OF ^{244}Cm PRODUCED FOR ISOTOPIC POWER GENERATORS. D. H. Stoddard, comp. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Nov. 1964. Contract AT(07-2)-1. 26p. Dep.; $2.00(OTS).

The radiation properties of curium (~95 wt % ^{244}Cm) that would be produced in a large-scale program at the Savannah River Plant are similar to the properties of pure ^{244}Cm. The alpha, gamma, and neutron radiations associated with the ^{244}Cm product are presented for evaluation by users of ^{244}Cm as a heat source in isotopic power generators. (auth)

6226 (MND-P-2640(Rev.2)) INSTRUCTION MANUAL—SNAP-7C ELECTRIC GENERATION SYSTEM. (Martin-Marietta Corp. Aerospace Div., Baltimore). Oct. 1, 1961, First Revision Dec. 20, 1961, Second Revision Nov. 20, 1964. Contract AT(30-1)-3296. 36p. Dep. (mn); $2.00(cy), 1(mn) OTS.

A description, the operational limits, and transportation, handling, installation, and adjustment procedures are given for the SNAP-7C electric generation system. It is used to power a U. S. Navy automatic weather station. In addition, maintenance instructions and emergency and safety precautions are included. (auth)

6227 A RADIOISOTOPE POWERED ACOUSTIC BEACON. Marvin P. Norin (Martin-Marietta Corp., Baltimore). 4p. (CONF-446-70)

From American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

An acoustic beacon system is described in which the energy produced by the decay of a radioisotope is converted into acoustic energy through generation of steam which drives a hydroacoustic oscillator. (D.C.W.)

Separation and Production

6228 (CEA-Bib-45) DIFFUSION THERMIQUE. (Thermal Diffusion). Gérard Taniel (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1964. 27p. Dep.(mn).

This bibliography of 287 references covers the years 1957 to June 1963 and is intended to supplement previous bibliographies. The references are arranged by the year. (D.L.C.)

6229 A LABORATORY SOURCE OF TRITIUM WITH APPLICATIONS IN NEUTRON DOSIMETRY AND Li^6 ANALYSIS. H. Cohen and W. S. Diethorn (Pennsylvania State Univ., University Park). Intern. J. Appl. Radiation Isotopes, 15: 553-5(Sept. 1964).

Irradiation of LiF produces 1 μC of ^3H per milligram of natural LiF per 1.25×10^{16} nvt of thermal neutrons via the $^6Li(n,\alpha)^3H$ reaction. Melting the LiF liberates ^3H. Liberation and radioassay of ^3H is carried out in a system consisting of a Vycor tube heated by an electric furnace, a regulated supply of dry sweep gas containing hydrogen, a 50 cm^3 stainless steel ionization chamber, and a vibrating reed electrometer with 10 mv recorder. The $^6Li(n,\alpha)^3H$ reaction has almost a v^{-1} cross section up to 20 Mev and thus may be used for neutron dosimetry. The relationship between tritium radioassay and ^6Li content is linear so ^6Li content can be determined in this way. (M.C.G.)

6230 DETERMINATION OF THE IMAGE CURVE IN AN ELECTROMAGNETIC ISOTOPE SEPARATOR WITH INHOMOGENEOUS MAGNETIC SECTOR FIELD. F. P. Viehboeck (Osterreichische Studiengesellschaft fur Atomenergie GmbH, Seibersdorf, Austria), H. Wotke, and F. Ruedenauer. Z. Naturforsch., 19a: 1333-4(Nov. 1964). (In German)

The coordinate system and measuring arrangement for determination of the image curve in an electromagnetic isotope separator are shown and the calculated and experimental image curves given. (M.C.G.)

6231 SEPARATION OF ISOTOPES BY THE ION MOBILITY METHOD. III. SEPARATION BY ISOTOPIC EXCHANGE. B. P. Konstantinov and V. B. Fiks (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Fiz. Khim., 38: 2255-7(Sept. 1964). (In Russian)

Separation of lithium isotopes by ion and molecular exchange in incompletely dissociated electrolyte was studied. Formulas were obtained for separation in a fractionating column taking into account the exchange. The relative mobility of isotopic ions is a function of their own rate of mobility and isotopic exchange constants. Transitions between ionic and molecular forms mixed the isotopes even in an ideal column. Efficient differential coefficients in an exchange column depend on the exchange current. Measurements of γ_{eff} for ^6Li and ^7Li in $LiSO_4$ were made at various electrolyte concentrations. It is shown that the γ_{eff} increased faster with $LiSO_4$ concentrations than with LiCl. (R.V.J.)

6232 SEPARATION OF POTASSIUM AND RUBIDIUM ISOTOPES BY THEIR MOBILITIES IN KCl AND RbCl SOLUTIONS. V. B. Fiks (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Fiz. Khim., 38: 2257-9(Sept. 1964). (In Russian)

Ion mobility was used in a partial separation of K and Rb in KCl and RbCl aqueous solutions. Fractionation columns proved to be sufficiently efficient for measuring relative differences in isotopic ion mobility and in the analysis of the mechanism of separation. (R.V.J.)

6233 MEASUREMENT OF EQUIVALENT DIFFUSION COEFFICIENTS IN THE SEPARATION OF ISOTOPES BY THE IONIC MOBILITY METHOD. V. B. Fiks and E. V. Stepin (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Fiz. Khim., 38: 2260-2(Sept. 1964). (In Russian)

An analysis of fractionation column performance with various packings showed that material coarseness between 20 to 40 μ in 0.5 to 1 mm diameter columns at $E \leq 30$ v/cm is ideal. The structure of the packing influences column efficiency. (R.V.J.)

6234 TEMPERATURE DEPENDENCE OF THE RELATIVE DIFFERENCE IN MOBILITIES OF ISOTOPIC LITHIUM IONS. E. A. Bakulin, V. P. Troshin, and V. B. Fiks (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Fiz. Khim., 38: 2262-3(Sept. 1964). (In Russian)

Temperature and concentration dependence of the relative difference in lithium isotopic ion mobility in LiCl, $LiNO_3$, and Li_2SO_4 confirmed the existence of an isotopic separation mechanism in Li_2SO_4 related to isotopic exchange. (R.V.J.)

MATHEMATICS AND COMPUTERS

Refer also to abstracts 5823 and 6151.

6235 (AI-Memo-9201(Rev.1)) ABSTRACTS OF AVAILABLE CODES AT ATOMICS INTERNATIONAL. R. A. Blaine (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Apr. 1964. Contract AT(11-1)-Gen-8. 149p. Dep.(mn); $4.00(cy), 5(mn) OTS.

Revision 1 to AI-MEMO-9201 (Code Abstracts) contains sections XIX–XXIII (mathematics, economics, ... and graphical display codes and subroutines) which were not included in the original document. In addition, fifteen nuclear codes have been added. The abstracts are representative of the codes available at Atomics International but are not complete. Many codes of special application are not included. AI-MEMO-9201, November 1963, is obsolete with the publishing of this Revision 1. (auth)

6236 (KAPL-M-6416) MATHEMATICAL PROGRAMS AVAILABLE ON THE PHILCO-2000 COMPUTER. PART 2. CURVE PLOTTING. G. L. Lechliter, A. L. Liedel, and J. R. Schmid (Knolls Atomic Power Lab., Schenectady, N. Y.). Oct. 16, 1964. Contract W-31-109-eng-52. 21p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Three computer programs that can be used in conjunction with the CALCOMP plotter for automatically drawing graphs on $8\frac{1}{2}'' \times 11''$ unruled paper are described. The three programs discussed are: EQPLT—a program that reads equations as input and plots the results, useful for parameter studies; FITUM—a program that reads arrays of input data and plots the graphs as directed; and APPLE—a subroutine that can be compiled with existing programs to plot results. (auth)

6237 (SC-R-64-1359) DISPOSITION ANALYSIS. L. W. Rook (Sandia Corp., Albuquerque, N. Mex.). Nov. 1964. Contract [AT(29-1)-789]. 13p. Dep.; $1.00(cy), 1(mn) OTS.

Sandia Corp. Monograph.

A technique is described by which the latent structure model of multivariate analysis may be applied with only moderate computational effort. The technique, termed disposition analysis, is based upon defining a functional relationship between variables and patterns of variables. Both continuous and discontinuous variables may be treated separately or intermixed. (auth)

6238 A GENERAL COMPUTER PROGRAMME FOR THE MANIPULATION AND ANALYSIS OF GAMMA-RAY SPECTRA. L. Salmon (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Vienna, International Atomic Energy Agency, 1964, Preprint SM-55/21, 22p. (CONF-641001-45)

From Symposium on Radiochemical Methods of Analysis, Salzburg, Austria.

A computer program (GASP) for the manipulation of data from pulse-height analyzers was written for the IBM-7030 (STRETCH). The object of the program was to obtain ease of operation combined with as many facilities as possible for the analysis of scintillation gamma spectra. A special data input system was used that allows almost any punched card data to be used irrespective of its format. Instructions and specifications are included in the data in the form of appropriate English words punched on cards. If errors occur inadvertantly anywhere in the data, the current spectrum under analysis is abandoned but the programme continues with the one following without interruption in the operation of the computer. Simple facilities are available for the reduction and presentation of pulse-height data together with automatically plotted spectra on paper microfilm. Standards may be used to calibrate a system in terms of energy; spectra subsequently obtained can be converted to any required values of channel width and bias at will. Linear least squares analysis may be performed on spectra of known composition using standards read at execution time or stored on a library tape. Various permutations of standards may be used for the analysis of each spectrum. For spectra of unknown composition, analysis of peaks is performed by non-linear least squares analysis on the assumption that the total absorption peaks are Gaussian in shape. Various options for curve fitting are present and monoenergetic spectra may be synthesized from an analytic function. Facilities are available for the standard stripping technique to be used and correction for radioactive decay may be made. Examples of the use of this program in analysis of fallout debris, tracer studies, and activation analysis of aerosols and organic material are included. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

General

6239 (ASD-8-108(VI)) DEVELOPMENT OF PROCEDURES FOR SHAPE ROLLING COLUMBIUM ALLOYS. Technical Progress Report, Sixth Interim Report, July 1, 1964 to October 1, 1964. F. R. Cortes (Universal-Cyclops Steel Corp., Bridgeville, Penna.). 28p. (AD-450079).

Factors influencing the selection of Cb-752 shape rolling parameters are discussed both for hot rolling and low temperature finish rolling. A tentative roughing pass sequence is selected and the ability of finish pass designs to produce a hat shape meeting dimensional objectives is discussed. (auth)

6240 (ASD-8-170(V)) HOT-WORKING EVALUATION OF REFRACTORY AND REACTIVE METALS. Fifth Interim Report, July 1, 1964 to September 30, 1964. John Bonchak (Universal-Cyclops Steel Corp., Bridgeville, Penna.). Oct. 1964. Contract AF33(657)-11270. 57p. (AD-449836)

Sheet bars of TZM, T-222, and Cb-752 alloys were produced by hot-work forging. The same materials were also forged to sheet bar by employing conventional processing temperatures. Preliminary evaluations indicate that the hot worked material condition shows promise for improved properties. (auth)

6241 (BM-RI-6558) DEVELOPMENT OF COLUMBIUM AND TANTALUM ALLOYS FOR ELEVATED-TEMPERATURE SERVICE. H. R. Babitzke, R. E. Siemens, G. Asai, and H. Kato (Bureau of Mines. Albany Metallurgy Research Center, Ore.). May 1964. 37p. Free(Bureau of Mines).

Sixty-nine columbium and tantalum alloys were investigated. For this study, columbium was alloyed with two or more of the following: hafnium, tungsten, vanadium, titanium, and zirconium. Tantalum was alloyed with vanadium or hafnium, or hafnium and carbon. The fabricability was determined by an arbitrary procedure. Hardness measurements, elevated-temperature tensile properties, and oxidation-resistance studies were made. Of the alloys studied, Cb-15Hf-5W, Cb-15Hf-5W-10Ti, Cb-15Hf-10W-10Ti, Cb-10V-5W, Ta-30V, and Ta-20 to 33Hf exhibited excellent high-temperature properties. These alloys were not only easy to fabricate, but they also had good oxidation resistance and excellent high-temperature strength. (auth)

6242 (BMI-1690) PREPARATION AND PROPERTIES OF CAST UN. Roy W. Endebrock, Ellis L. Foster, Jr., and Donald L. Keller (Battelle Memorial Inst., Columbus, Ohio). Aug. 28, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract W-7405-eng-92. 24p. (EURAEC-1206). Dep.; $0.50(OTS).

Methods were developed to prepare uranium mononitride, both as polycrystalline material and as large single crystals, by consumable-electrode arc-melting procedures. UN single crystals exhibited an average Knoop hardness of 555 and a Vickers hardness of 515. Densities obtained by the displacement technique varied from 99 to 100 per cent of theoretical. Congruent melting occurred at 2850 ± 50°C at and above a nitrogen pressure of 2.5 atm. An initial film of oxide which formed on crystal surfaces offered protection from further oxidation. Some information regarding UN structure as determined from single crystals of UN was also obtained. Hot-hardness values for single crystals at 1000°C and above were about 30 per cent lower than those of hot isostatically pressed UN powder. Hardness varied from about 90 DPHN at 1000°C to about 25 DPHN at 1400°C. Thermal conductivity varied linearly from 0.04 to 0.062 cal/cm sec °C over the 50 to 1000°C temperature range. Electric resistivity for polycrystalline and monocrystalline UN varied from 157 microhm-cm at 25°C to 194 microhm-cm at 1000°C. TiN alloyed with UN appeared to act synergistically to maintain UN stoichiometry at the expense of TiN nitrogen solubility. (auth)

6243 (BMI-1703) NITROGEN-INDUCED INTERNAL FRICTION IN CHROMIUM–35 a/o RHENIUM. Mark J. Klein (Battelle Memorial Inst., Columbus, Ohio). Nov. 24, 1964. Contract W-7405-eng-92. 20p. Dep.; $0.50(OTS).

An internal-friction profile induced by nitrogen in chromium-35 at.% rhenium was studied as a function of nitrogen concentration and heat treatment. From these studies, the solubility of nitrogen in this alloy was deduced. The equilibrium solubility of nitrogen in this alloy did not differ significantly from that in chromium determined by internal-friction techniques. However, the precipitation kinetics of nitrogen from solution appear to be slower in the alloy than in chromium. (auth)

6244 (CEA-R-2505) OBSERVATIONS SUR LA GRANULOMETRIE DES PRODUITS D'OXYDATION DE L'URANIUM DANS L'AIR OU LE GAZ CARBONIQUE. (Observations Concerning the Particle Size of the Oxidation Products of Uranium Formed in Air or in Carbon Dioxide). Pierre Baque and Daniel Leclercq (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). Aug. 1964. 16p. Dep.(mn).

Particle-size analysis results which were obtained on products formed by the oxidation or the ignition of uranium in moist air or dry carbon dioxide. The results bring out the importance of the nature of the oxidising atmosphere, the combustion in moist air giving rise to the formation of a larger proportion of fine particles than combustion in carbon dioxide under pressure. (auth)

6245 (DMIC-206) AN INTRODUCTION TO MAGNESIUM ALLOYS. John B. Hallowell and H. R. Ogden (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Aug. 26, 1964. Contract AF33(615)-1121. 20p. (AD-608142). $2.00(OTS).

The characteristics and properties of existing commercial magnesium alloys are described and compared. The nomenclature system for commercial magnesium alloys is described. Currently, eight major "alloying" elements are being used to control the properties of magnesium. Over 30 magnesium alloys are described and specific compositions and the available forms of the alloys are presented. Selected physical properties of the casting alloys are given along with room-temperature tensile properties, relative ratings of castability, weldability, and indicated advantages attributed to each alloy. Joining methods applicable to magnesium include arc and resistance welding, brazing, mechanical joining, and adhesive bonding. Relative to another facet of fabrication, most forming operations are done at elevated temperatures. Small deformations such as simple bending around large radii can be performed at room temperature. However, formability increases rapidly above 200 to 400°F, depending on the alloy. Finally, a discussion is given of a number of finishing systems which have been developed specifically for magnesium alloys: chemical conversion or anodic treatments followed by painting. (D.L.C.)

6246 (EUR-1834.e) AN ATTEMPT TO CORRELATE DIFFUSION AND ELECTRON MICROSCOPY IN KRYPTON-BOMBARDED PLATINUM FOILS. R. Kelly and E. Ruedl (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1964. 10p. (CONF-806-2). Dep.(mn).

From 3rd European Regional Conference on Electron Microscopy, Prague, Aug.-Sept. 1964.

Previous electron-microscope studies of Pt foils bombarded with alphas or fission fragments have shown that there are characteristic temperatures for both loop annealing and for the development of bubbles. At the same time, diffusion studies on various inert-gas-bombarded targets have revealed the presence of three distinct processes. It is shown that it is possible to correlate the

electron microscopy with the diffusion. Pairs of Pt targets were bombarded with 9-kev Kr ions (either natural or radioactive) to doses of between 0.2 and 190 μa min/cm^2. The targets with the natural Kr, which had been prethinned, were used for microscope study; those with radioactive Kr were used for diffusion measurements. It was found that the temperature at which the loops began to anneal (500°C) was similar to that for the commencement of "normal diffusion", i.e. diffusion which agrees with conventional data (475°C). The implied activation enthalpy was 53 ± 4 kcal. Likewise, the presence of uniformly distributed bubbles, as distinct from occasional patches of bubbles coincided with the existence of a component of "bubble diffusion", i.e. diffusion characterized by excessively high temperatures. The condition for observing "bubble diffusion" was that the bombardment dose be high (19 or 190 μa min/cm^2). (auth)

6247 (EUR-1847.f) DIMENSIONI DEI SUB-GRANI N ESTRUSI DI SAP 4, 7, 10 ev 14% Al_2O_3, RICOTTI A 600 E A 650°C. (Sub-Grain Size in 4, 7, 10, and 14% Al_2O_3 SAP Extruded Bars Thermal Treated at 600 and 650°C). M. Paganelli (Istituto Sperimentale Metalli Leggeri, Novara, Italy). 1964. 49p. (CONF-425-6) Dep.(mn).

From Conference on Nonfissile Metals for Nuclear Reactors, Bologna, Dec. 1963.

SAP extruded bars show a sub-grain structure, and the average linear size of sub-grains is about 1.1 μ for the 4% Al_2O_3 SAP and about 0.45 μ for the 14% Al_2O_3 SAP. Subgrain boundaries are generally affected by oxide particles; also, the dislocations inside the sub-grains are normally pinned by oxide particles. A thermal treatment at 600 and 650°C causes a strong decrease of dislocation number inside and at boundaries of sub-grains. In the thinned samples of SAP, oxide particles are surrounded by a halo, which is probably produced by an elastic strain of the aluminium lattice; this halo is not affected by thermal treatment. In SAP extruded bars, a thermal treatment at 600 and 650°C does not increase the sub-grain size, which remains nearly the same as in high work-hardened rolled sheets; so it may be pointed out that during extrusion or subsequent thermal treatments, SAP does not undergo recrystallisation. (auth)

6248 (EUR-2109.f) TESTS NON DESTRUCTIFS SUR TUBES DE GAINE ORGEL. (Non-destructive Testing of ORGEL Tubular Fuel Cans). P. Bonnet, E. Borloo, and J. Jansen (European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1964. 70p. Dep. (mn).

The control of tubes to be used in the ORGEL reactor is carried out by different techniques sensible to diverse kinds of defects. The comparative efficiency of various methods is analyzed. The adaptation of some of these is described: ultrasonics, eddy currents, radiography. The ultrasonic method seems to be the most suitable one although it required rather diversified experiments in order to determine the most adequate procedure for each case. Among those the choice of the immersion method, the detection of defects of axial or circumferential orientation, the reflection (one single transducer) or transmission method (two transducers), as well as the use of focalized transducers are mentioned. The various methods are compared and three types of fittings described which are intended to investigate tubes in the laboratory or within a semi-industrial context. The radiography may be retained for intersection and control purposes if contrast and resolution are carefully worked out. In this connection a single wall technique, the so-called radiorotative technique, is described. Calculations have been initiated on the interaction of various parameters such as time and resolution. Other methods which at present are being investigated are quoted. One of these is applicable to small-diameter tubes. Investigations have been made on eddy currents in the field of pulses. Various techniques of visual examination (penetrant liquids, latex replica) and dimensional measures have been tested and compared. (auth)

6249 (EURAEC-1111(Pt.1)) SURVEY OF SOME PROBLEMS OF METAL OXIDATION AND APPLICATION OF IMPEDANCE MEASURING METHODS TO THE SURVEY OF RESISTANCE TO CORROSION IN AN AQUEOUS MEDIUM. Quarterly Report No. 9, April 1–June 30, 1964. (Brussels. Université). Work Performed under United States–Euratom Joint Research and Development Program. Contract 012-63-10 TEEB. 12p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The oxidation of aluminum and nickel at high temperatures and iodization of copper at 300 to 450°C are analyzed. (N.W.R.)

6250 (GAT-T-1219(Rev.1)) SOME ULTRA-MICROTOMY STUDIES OF NICKEL FLUORIDE FILMS ON NICKEL FOIL. F. C. Steinbach and K. E. Beu (Goodyear Atomic Corp., Piketon, Ohio). Oct. 2, 1964. Contract AT(33-2)-1. 14p. (CONF-668-4). Dep.(mn); $1.00(cy), 1(mn) OTS.

From Electron Microscope Society of America 22nd Meeting, Detroit, Oct. 1964.

Electron microscopic observations are presented of ultra-microtome sections of fluoride films formed on Ni foil. The film thickness and annealing effects are discussed. The adhesion of the film to the metal during the cutting is pointed out. (D.L.C.)

6251 (IS-977) GROWTH OF GADOLINIUM SINGLE CRYSTALS. Idelle Marietta Peterson and Morton Smutz. (Ames Lab., Ames, Iowa). July 1964. Contract W-7405-eng-82. 35p. Dep.; $2.00 (OTS).

An attempt was made to prepare Gd single crystals by the strain-anneal method. Two large grains were obtained which are relatively strain-free. Tapered tensile specimens can be used to find the critical strain. (D.L.C.)

6252 (IS-984) A PROCESS FOR PURIFYING YTTRIUM METAL. O. N. Carlson, J. A. Haefling, and F. A. Schmidt (Ames Lab., Ames, Iowa). Sept. 1964. Contract W-7405-eng-82. 17p. Dep.; $1.00(OTS).

A process is described for purifying crude or scrap yttrium metal by first reacting the yttrium with fused $MgCl_2$ and then purifying the magnesium and YCl_3 products by co-distillation. Dissolution and purification are carried out in a single heating step. The purified YCl_3 is reduced with calcium in the presence of the magnesium to form a Y–Mg intermediate alloy which is processed to yttrium sponge. Further refinement of the metal was obtained employing a salt extraction step and electron beam melting. Yttrium of 99.9+% purity was obtained from metal of 99.3% purity. (auth)

6253 (ML-TDR-64-269) AN APPROACH TO THE PREPARATION OF POWDERS, FIBERS, AND FILMS OF ULTRA-HIGH-PURITY CERAMICS. K. S. Mazdiyasni and C. T. Lynch (Research and Technology Div. Air Force Materials Lab., Wright-Patterson AFB, Ohio). Aug. 1964. 41p. (AD-608043). $2.00 (OTS).

Specifically selected organo-metallic compounds can be made which will decompose to form familiar ceramic materials such as the refractory borides, carbides, nitrides, and oxides. This approach provides unlimited flexibility in the selection of starting compounds because of the great variety of organic compounds available. The thermal decomposition of organo-metallic compounds in the vapor phase produces high purity, fine particle size powders, coatings and thin films, or fibers, by controlled pyrolysis conditions. Transition and rare earth metal alkoxides have been investigated. Compounds of the type $M(OR)_3$ and $M(OR)_4$ where M is Ti, Zr, Hf, Th, Y, Yb, and Dy, and various alkyl groups such as C_4H_9- and C_5H_{11}- have been studied. The metal-oxygen bond in these compounds is very stable and thermal decomposition is complete to the oxides. A method has been developed to produce on a continuous basis zirconia and hafnia with an average particle size of less than 100Å and a purity of 99.95+ percent. Adherent coatings of refractory oxides on graphite have been made by thermal decomposition of the alkoxides at the substrate surface. (auth)

6254 (MLM-1205) PLASMA SPHEROIDIZED ZIRCONIA. D. B. Sullenger and K. D. Phipps (Mound Lab., Miamisburg, Ohio). July 1, 1964. Contract AT(33-1)-Gen-53. 18p. Dep.; $1.00(OTS).

The induction-coupled plasma torch was utilized to pre-

pare microspheroids of zirconium dioxide and plutonium dioxide–zirconium dioxide. Powder x-ray diffraction photographs of the zirconium dioxide microspheroidized in a 50% argon–50% oxygen atmosphere indicated the presence only of the monoclinic form with typical lattice parameters. Several of the more transparent 100-micron diameter spheres were highly strained single crystals, as revealed by Laue photography, and exhibited approximate monoclinic lattice parameters. One sphere oriented so as to exhibit 4-fold internal symmetry yielded tetragonal lattice parameters of a = 3.64 A, c = 5.24 A via precession and Weissenberg photography. Under 2537 A and 3650 A ultraviolet light, an appreciable variation in fluorescence was noted for a few individual spheres. The density of the zirconium dioxide microspheres was approximately 5.5 grams per cubic centimeter. The high temperature form of zirconium dioxide was stabilized with 27 mole per cent plutonium dioxide. The stabilized product has a body centered tetragonal lattice with parameters of a = 3.622 A; c = 5.192 A. Fifty mole per cent plutonium dioxide produced a cubic lattice with a = 5.261 A. (auth)

6255 (NASA-TN-D-2513) INFLUENCE OF CRYSTAL STRUCTURE ON FRICTION CHARACTERISTICS OF RARE-EARTH AND RELATED METALS IN VACUUM TO 10^{-10} MILLIMETER OF MERCURY. Donald H. Buckley and Robert L. Johnson (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Nov. 1964. 17p. $0.50 (OTS).

Friction, wear, and metal-transfer characteristics were determined for lanthanum, neodymium, praseodymium, cerium, holmium, erbium, gadolinium, dysprosium, samarium, yttrium, and thallium sliding on 440-C stainless steel in vacuum to 10^{-10} mm Hg. Experiments with lanthanum sliding on lanthanum were also conducted. The results obtained indicate that crystal structure markedly influences the friction, wear, and metal-transfer characteristics of the rare-earth and related metals in vacuum. The normal close-packed hexagonal crystal form had much better friction and wear characteristics than face-centered or body-centered cubic structures. (auth)

6256 (NCSC-2663-18) URANIUM INTERSTITIAL PHASES. Quarterly Report. J. V. Hamme, R. F. Stoops, and G. S. Sheffield (North Carolina State Coll., Raleigh). Sept. 1964. Work Performed Under United States–Euratom Joint Research and Development Program. Contract AT-(40-1)-2663. 18p. (EURAEC-1229) Dep.(mn); $1.00(cy), 1(mn) OTS.

Approximately 500 grams of U(C,O) with a lattice parameter of 4.953 Å were made containing approximately 3% UO_2 and no uranium metal detectable by x-ray diffraction. Hot-pressed pellets of this material were made with little or no change in lattice parameter and with densities as high as 93.9% of theoretical. A limited number of measurements made to date have not revealed any correlation between the hardness and change in lattice parameter (oxygen content). (auth)

6257 (NP-14535) VAPORIZATION KINETICS OF NON-STOICHIOMETRIC COMPOUNDS. Semi-Annual Progress Report No. 2, September 1, 1963–March 1, 1964. Harold Bernstein and Larry Kaufman (ManLabs., Inc., Cambridge, Mass.). Mar. 15, 1964. Contract AF33(657)-9826. 46p.

The vaporization kinetics of a non-stoichiometric solid phase such as NbC or ZrC has been analyzed on the basis of a Schottky-Wagner model of the solid, Langmuir vaporization rates of the elements, and non-diffusion limited mass transport. The time dependence of the weight and composition of a vaporizing specimen of constant area has been calculated for both congruent and non-congruent vaporization. The parameters controlling the process are starting composition, stoichiometric composition, vapor pressures and molecular weights of the pure elements, temperature dependence of the phase boundaries, free energy of formation of the stoichiometric compound, and specimen geometry. (auth)

6258 (NP-14537) BIBLIOGRAPHY ON THE HIGH-TEMPERATURE CHEMISTRY AND PHYSICS OF MATERIALS IN THE CONDENSED STATE. Volume 1964, No. 3, July–September 1964. J. J. Diamond, ed. (National Bureau of Standards, Washington, D. C.). 68p.

A total of 711 references are presented on devices for obtaining and controlling temperatures above 1500°C, on properties below and above 1000°C of materials which melt below and above 1500°C, phase equilibria, and reactions above 1000°C. (D.L.C.)

6259 (NUMEC-3432-3) IRRADIATION TESTING OF UO_2–PuO_2 FUELS. Quarterly Progress Report, July 1–September 30, 1964. (Nuclear Materials and Equipment Corp., Apollo, Penna.). Contract AT(30-1)-2389. 20p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The characteristics of fuel pellets prepared from coprecipitated plutonia–urania and pellets fabricated from feed material prepared by the mechanical mixing of component powders are presented. The sintering conditions, density of the pellets, microstructures of the fuel materials, autoradiographs of the pellets, grain structure, porosity, phase studies, fabrication techniques, and burnup conditions are defined. (N.W.R.)

6260 (RISO-48(Suppl.1)) BIBLIOGRAPHY ON DISPERSION-STRENGTHENED MATERIALS, 1962–1963. Niels Hansen, Hans Lilholt, and Monika Hahnkamm (Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). July 1964. 81p. Dep.(mn).

This annotated bibliography consists of 488 references to available literature on dispersion-strengthened materials and related problems. A subject index is included. (auth)

6261 (RISÖ-89) REVIEW OF THEORIES OF SINTERING. N. C. Kothari (Denmark. Atomenergikommissionen. Forsøgsinstitut, Risø). July 1964. 24p. Dep.(mn).

Theories on sintering mechanism are reviewed. The importance of grain boundaries acting as strong vacancy sinks is discussed. It has been suggested that at the lower temperature (<0.5 T_m), sintering proceeds by the grain boundary diffusion; while at the high temperature (>0.5 T_m), the volume diffusion is the operative mechanism. (auth)

6262 (USBM-RC-1135) QUARTERLY METALLURGICAL PROGRESS REPORT NO. 24, JULY 1–SEPTEMBER 30, 1964. (Bureau of Mines. Albany Metallurgy Research Center, Ore.). Contract AT(11-1)-599. 33p. Dep.; $2.00 (cy), 1(mn) OTS.

Improvements in the HfC casting equipment led to preparation of cast-to-shape threaded tensile specimens. The tensile strength of HfC castings containing excess C was determined. Strengths of 5,840 to 6,540 psi at 2,420 to 2,470°C were calculated from the test data. Environmental chamber temperature corrections and vaporization losses for hafnium carbides were studied prior to conducting reactivity studies. Equipment was assembled for coating ThO_2 with both organic binders and Th. Several trial runs were made with the equipment. Various organic binders were evaluated for their effect on increasing the carbon content of the thorium metal. The cold-mold induction furnace research continues with further modification indicated. Latest arrangements have the feed rod and ingot mounted on a vertical axis, the intensifier horizontal. Investigations have continued on the UC–UO and UN–UO binary systems and have been started on selected ternary compositions. The main effort is being placed on determination of the degree of solubility of UO in the structure of UC, UN, and UC–UN compositions. Extreme sensitivity of the powders to O_2 and moisture required a continual program of refinement of techniques. With the redirection of the melting research on the W–Re tubing program, emphasis was placed on preparation of cold-mold ingots. To date, four were melted and are being conditioned preparatory to extrusion. Evaluation of W–25 Re sleeves was continued and density, Re content, impurity content, and grain size data were obtained. (auth)

6263 (NASA-TT-F-263) THE STATE OF CARBON IN TITANIUM, TANTALUM, AND TUNGSTEN. I. N. Frantsevich and I. I. Koven'skii (Koven'skiy). Translated from Dopovidi Akad. Nauk Ukr. RSR, No. 11, 1471-4(1961). 11p. $0.50(OTS).

An investigation was conducted of carbon electrotrans-

port in titanium, tantalum, and tungsten, the carbon content being 0.1 percent by weight. The experimental data were used to determine the charges of the carbon ions in the given metals. (auth)

6264 IN-CELL VACUUM IMPREGNATION OF METALLOGRAPHY SPECIMENS. F. L. Cochran and H. E. Shoemaker (General Atomic Div., General Dynamics, San Diego, Calif.). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 239-43.

The problem of preparing porous, damaged, or badly cracked irradiated specimens for metallographic analysis was solved by vacuum impregnation of the specimens prior to preparation. It was found that the most desirable impregnating material was a mixture of Epon 815, Epon 812, and allyl glycidyl ether, using Dmp-10 as the hardening catalyst. The extremely low viscosity and long curing time of the epoxy compound resulted in complete impregnation at vacuum levels of from 1 to 30μ. The impregnation apparatus was designed to accommodate a modified vacuum desiccator, which permitted impregnation and simultaneous mounting of from one to ten specimens during a single impregnation cycle. Direct radiation fields of from 5,000 to 10,000 R/hr did not embrittle the epoxy compound. (auth)

6265 CONFERENCE ON NEW TECHNOLOGY, LEWIS RESEARCH CENTER, CLEVELAND, OHIO, JUNE 4-5, 1964. (National Aeronautics and Space Administration, Washington, D. C.). 1964. 159p. (NASA SP-5015; CONF-640601). $1.00 (GPO).

Information concerning problems and interests of the research center are presented under nine topics. Separate abstracts were prepared for six topics. Those topics for which no abstracts were prepared are concerned with lubrication in difficult environments, instrumentation for measurement and control, and information sources. (J.R.D.)

For abstracts of individual papers see: 6286, 6352, 6353, 6500, 6616, and 6811.

6266 ELECTRODE EROSION CHARACTERISTICS OF PULSED PLASMA ACCELERATORS. T. L. Rosebrock, D. L. Clingman, and D. G. Gubbins (General Motors Corp., Indianapolis). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-708, 36p, $1.00. (CONF-640801-27)

From 4th Electric Propulsion Conference, Philadelphia.

Existing theories based on quasi-steady state discharges are shown to be inapplicable to quantitative predictions of erosion in short time pulsed discharges. Extensive experiments are described which demonstrate that the total eroded mass is several orders of magnitude lower than previously predicted. Photometry, polarography and x-ray fluorescence were used in the quantitative determination of the mass of the erosion products, which were collected on filter paper completely surrounding the discharge. For several elements, a new method was developed which combined the techniques of forming confined spots on paper containing the elements and x-ray fluorescence. Typically, erosion mass on the order of 0.4% of the propellant mass is encountered. The results were checked in two different ways and were found to be consistent. The factors which influence erosion (electrode conditioning) are also discussed. It is concluded that erosion in the amount encountered is not prohibitive; further reduction or suppression of electrode erosion in pulsed plasma accelerators through the application of appropriate corrective measures appears to be feasible. (auth)

Corrosion

6267 (BMI-X-316) CORROSION INVESTIGATION OF HyMu 80, INOR-8, AND "L" NICKEL UNDER FLUORINATION CONDITIONS FOR PROCESSING ALUMINUM USING THE MOLTEN-SALT FLUORIDE-VOLATILITY METHOD. P. D. Miller, E. F. Stephan, W. N. Stiegelmeyer, and W. K. Boyd (Battelle Memorial Inst., Columbus, Ohio). Oct. 30, 1964. Contract [W-7405-eng-92]. 13p. Dep.(mn); $1.00 (cy), 1(mn) OTS.

A study was made of the corrosion of the three metals in molten $AlF_3-KF-ZrF_4$ under fluorination conditions at 600°C. The results, compared with previous data for Zr processing salts, indicate higher corrosion rates (possibly due to the use of 600 rather than 500°C) and a slight superiority of HyMu 80 to INOR-8. Previous data for hydrofluorination + fluorination are also given which indicate that the Al processing salt is less corrosive than the Zr processing salts. (D.L.C.)

6268 (IS-854) OXIDATION STUDIES OF SOME REFRACTORY METALS. James Henry Witte and Harley A. Wilhelm (Ames Lab., Ames, Iowa). Feb. 1964. Contract W-7405-eng-82. 36p. Dep.; $2.00(cy), 1(mn) OTS.

Samples of niobium, tantalum, molybdenum, and tungsten metals have been given phosphided cases by heating in a phosphorous atmosphere. The samples were subsequently exposed to air at an elevated temperature. In tests at 800°C, the phosphided samples resisted air oxidation markedly compared to the pure untreated samples. The phosphided cases were only a few microns thick yet oxidation resistance of all these samples extended for several hours. Phosphided samples with 90° edges did not resist oxidation at the edges as well as rounded edge samples. (auth)

6269 (NP-14439) CORROSION PRODUCT SEPARATION IN A CROLOY 9M MERCURY LOOP. Second Quarterly Report, August 1, 1963-October 31, 1963. D. B. Cooper and E. J. Vargo (Thompson Ramo Wooldridge Inc. TRW Electromechanical Div., Cleveland). Nov. 20, 1963. Contract NAS 3-2538. 18p. (TM-3815-67)

Work is reported on fabrication of a forced-circulation loop to investigate corrosion product separation in Hg Rankine cycle power systems by hot trapping and magnetic effects. All components of the separators were fabricated during the period. Various loop sections were also completed along with electric service to the control console and thermocouple connections. Specimens of Croloy 9M were prepared for fabrication testing and chemical analysis. (J.R.D.)

6270 (WADD-TR-61-72(Vol.XXXIV)) RESEARCH AND DEVELOPMENT ON ADVANCED GRAPHITE MATERIALS. VOLUME XXXIV. OXIDATION-RESISTANT COATINGS FOR GRAPHITE. D. A. Schulz, P. H. Higgs, and J. D. Cannon (National Carbon Co. Advanced Materials Lab., Lawrenceburg, Tenn.). June 1963. Contract AF33(616)-6915. 116p. OTS.

The refractory materials that could be used for high-temperature, oxidation-resistant coatings for graphite are reviewed. A study of these materials shows those that are thermodynamically stable when applied directly to graphite and those that are thermodynamically stable when an intermediate coating is applied between an oxidation-resistant outer coating and the graphite. Calculations are made showing that, with properly selected intermediate reaction barriers, many very refractory oxides, such as thoria, can be used as coatings at temperatures up to their melting points. The application of TiB_2, B_6Si, $MgO \cdot ZrO_2$, $CaZrO_3$, and $SrZrO_3$ coatings by arc-plasma spraying is described and the results of oxidation studies to determine the protection afforded graphite by these coatings are presented. Coatings of TiC-TiN and SiC-Si applied to graphite by vapor deposition using the source-target method are discussed. Techniques of applying SiC coatings by pack-diffusion methods are reported and the oxidation protection afforded by the coatings is compared with that of the SiC produced by the source-target method. (auth)

6271 (JPRS-27451) CORROSION OF MAGNESIUM ALLOYS. M. A. Timonova. Translated from p.53-63; 114-18; 137-9 of "Korroziya i Zashchita Magnievykh Splavov," Moscow, 1964. 28p. (TT-64-51700) $2.00 (OTS).

Translations are presented of selected articles from the book "The Corrosion and Protection of Magnesium Alloys." These articles cover cast alloys, Al-Mg-Mn-Zn alloys, binary and ternary alloys with rare earths and other ele-

ments, Alloy VM65-1 (Mg–Zn–Zr), Mg–Mn–Th, Mg–Th–Zr, and Mg–Th–Zn–Zr. (D.L.C.)

6272 THE KINETICS OF THE OXIDATION OF TANTALUM CARBIDE. Ronald Lee Gibby. Thesis, Salt Lake City, Univ. of Utah, 1964. 75p.

Powdered samples of TaC (–200 + 270 mesh) were oxidized at various partial pressures of oxygen from 1.3×10^{-2} to 0.86 atmospheres in the temperature range 640–825°C and in pure oxygen in the range 600–630°C. Above 670°C the observed kinetics involved linear oxidation associated with the formation of a non-protective Ta_2O_5 layer. Between 670 and 650°C initial oxidation was non-linear but later changed to linear oxidation. From 640–600°C oxidation was extremely slow and parabolic oxidation was observed. Parabolic oxidation changed to linear oxidation before more than 25 per cent reaction had occurred, depending on the reaction temperature. Below 725°C a change in linear kinetics was observed. Oxidation is explained quantitatively in terms of equilibrium chemisorption of oxygen on TaC, in which oxygen splitting occurs on the surface, followed by dissolution of the oxygen atoms in the surface prior to the rate-controlling reactions. Two alternate mechanisms are discussed for the rate-controlling reactions. The more plausible mechanism embodies two parallel rate-controlling processes, a surface reaction with an activation energy of 108 kcal per mole and a diffusion reaction with an activation energy of 55 kcal per mole. The diffusion reaction is believed to be diffusion of oxygen into the TaC lattice partially replacing carbon. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

Fabrication

Refer also to abstract 6495.

6273 (AAEC/E-129) EXPERIMENTS IN EXTRUSION. PART 1. REVIEW OF THE THEORIES OF EXTRUSION. W. J. Wright (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Sept. 1964. 18p. Dep.(mn).

The theories of extrusion are examined. Considerable limitations exist in the analysis of extrusion conditions using either the semi-empirical approach, which is based on the assumption of homogeneous straining, or the slip-line approach. More information is required on the basic extrusion parameters such as yield stress and friction coefficient and on the variation of extrusion conditions with tooling geometry. (auth)

6274 (HW-82825) WELDING PLUTONIUM-CONTAINING FUEL ELEMENTS. L. C. Lemon, W. T. Ross, and W. J. Bailey (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 1964. Contract AT(45-1)-1350. 57p. Dep.; $3.00 (OTS).

Techniques employing the gas tungsten-arc, gas metal-arc, and cold pressing processes were developed for routinely welding plutonium-containing alloy and ceramic fuel element components. Reproducible, helium-tight (detection limit 5×10^{-10} standard cm^3) welds were obtained on Zircaloy-2, aluminum, and stainless steel cladding, 0.01 to 0.9 cm (0.005 to 0.35 in.) thick, with manual or automatic methods. Once-through yields to 99.5% were achieved, and completed fuel element components were free (<500 disintegrations/min) of external plutonium contamination. The 7500-plus fuel element components contained over 185 kg of plutonium (to 30 wt % ^{240}Pu). About one-half of the components were used for critical tests, and the remainder were irradiated under severe reactor operating conditions. No failures were attributed to welding. (auth)

6275 (LA-3139) THE FABRICATION OF LEAD–BORON CARBIDE COMPONENTS FOR KIWI NEUTRON-GAMMA COLLIMATOR. Haskell Sheinberg (Los Alamos Scientific Lab., N. Mex.). July 20, 1964. Contract W-7405-eng-36. 60p. Dep.; $3.00 (OTS).

A description is given of the details of operations required for the fabrication of lead–2.0 wt % boron carbide (B_4C) components for the Kiwi neutron-gamma collimator by powder metallurgy techniques. The process employed involved blending high purity commerical powders and warm pressing the blended powders in graphite dies. Size of pressed components varied in diameter from 4.54 to 26.08 in. and in thickness from 1.06 to 8.68 in. The weight varied from 16 to 403 lb. Chemical analysis of blended powders and pressed parts, results of radiographic inspection of typical pressed components, and temperature and pressure profiles for the warm pressings are included. (auth)

6276 (LA-3154) THE FABRICATION OF HOLLOW HEMISPHERES AND CYLINDERS OF TUNGSTEN CARBIDE–6 W/O COBALT. Haskell Sheinberg (Los Alamos Scientific Lab., N. Mex.). July 30, 1964. Contract W-7405-eng-36. 20p. Dep.; $1.00 (OTS).

A description is given of the details of die design, the powder preparation and loading, and the hot pressing operations employed to fabricate two 15.53-inch-OD × 10.20-inch-ID tungsten carbide-6 wt % cobalt hollow hemispheres with 3.95-inch-diameter polar cavities, and two 4.08-inch-diameter × 2.74-inch-long cylinders. The metallographic structure of the starting powder and of a core from one of the hot pressed hemispheres is described. (auth)

6277 (ML-TDR-64-205) RESEARCH ON HYDROSTATIC EXTRUSION OF THE TZM ALLOY AT AMBIENT TEMPERATURE. A. Bobrowsky and E. A. Stack (Pressure Technology Corp. of America, Woodbridge, N. J.). Mar. 1964. Contract AF33(657)-11236. 100p. (AD-607682). $4.00(OTS).

Tensile tests and compressive tests under pressures up to 450,000 psi on TZM molybdenum alloy, at room temperature, provided data on yield point, ultimate tensile strength, and ductility as a function of environmental fluid pressure. These data in turn indicate the initial feasibility of metalworking under pressure at room temperature without cracking or fracture. The specific metalworking process chosen was fluid-to-fluid extrusion. The fluid-to-fluid extrusion of TZM molybdenum alloy was conducted at room temperature at pressures up to 450,000 psi. It was determined that any of several fluids were suitable as the extrusion medium. Excellent finishes could be obtained even from rough-surface billets. Reductions in area up to 4:1 were made without fracture, although it is believed that much larger reductions are feasible. The experimental work was conducted on TZM molybdenum alloy in the forms of stress-relieved, recrystallized, and as-cast material. It was found that stress-relieved material actually was in a state of high residual stress. Techniques were developed for eliminating the difficulties caused by these stresses. Typical improvements in physical properties were increases in ultimate tensile strength, and in yield strength by 50% by fluid-to-fluid extrusion with a 2:1 reduction. The corresponding per cent elongation decreased 33% and the per cent reduction in area decreased 15%. (auth)

6278 (NAA-SR-8213) REFABRICATION AND ENCAPSULATION OF HIGHLY IRRADIATED URANIUM DIOXIDE. J. Guon, J. E. Bodine, and R. J. Sullivan (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 1, 1964. Contract AT(11-1)-Gen-8. 50p. Dep.; $1.25(OTS).

One hundred gram quantities of uranium dioxide, irradiated to burnups as great as 21,000 Mwd/MTU and previously reprocessed by AIROX (Atomics International Reduction Oxidation), were refabricated into high density pellets and encapsulated for reirradiation. Pellets were fabricated by cold pressing and sintering. Average densities, calculated from gas displacement and geometrical measurements, were 95.5 and 92.8% of theoretical density, respectively. Variation in pellet diameter, within a powder batch, was less than 0.002 in. Radiochemical analyses indicated that the principal fission products removed were cesium and the noble gases, and that plutonium was effectively retained during the processing cycle. All basic refabricating operations required for a large scale AIROX plant, except fuel reenrichment (not considered a difficult operation), have been successfully demonstrated. (auth)

6279 A CRITICAL COMPILATION OF CERAMIC FORMING METHODS. III. HOT FORMING PROCESSES. R. M. Fulrath (Univ. of California, Berkeley). Am. Ceram. Soc. Bull., 43: 880-5(Dec. 1964).

Hot-forming methods may be classified in the categories hot pressing, hot coining, hot rolling, hot extrusion, hot forging, hot swaging, and methods involving high rates of pressure application. Each of these methods is summarized briefly, and equipment used is described. (L.T.W.)

6280 HOT-PRESSING HIGH-DENSITY SMALL GRAIN SIZE BERYLLIA. Ralph E. Johnson (Atomics International, Canoga Park, Calif.). Am. Ceram. Soc. Bull., 43: 886-8 (Dec. 1964).

Hot-pressing has been favored for producing dense beryllia because higher densities are produced with this fabrication method than with sintering. Studies of beryllia hot-pressing have shown that the average grain sizes produced by hot-pressing are generally greater than those obtained by sintering. Since the strength of the material decreases with increasing grain size and since the high strength of beryllia ceramics is an important property in many applications a large grain size can be a disadvantage in high-density beryllia compacts. Two possible approaches are known which may produce hot-pressed beryllia with smaller grains. One is to include in the compact a small amount of additive which will collect in the grain boundaries and inhibit grain growth. The other is to vary the pressing parameters in such a way as to favor a slower grain growth. The disadvantage of the first method is that the final compact is not pure beryllia, but contains the additive which may be deleterious to the other useful properties of beryllia. The latter method includes the disadvantage that parameters which favor small grains also favor low density. Since both approaches contain inherent disadvantages, a variation in the usual method was used in which a new technique of hot-pressing was developed. (auth)

6281 CONTROL OF FUSION WELDING FOR FUEL-ELEMENT END-SEALS. A. F. Taylor and K. F. Barlow (United Kingdom Atomic Energy Authority, Springfields, Lancs, Eng.). J. Inst. Metals, 93: 89-95(Nov. 1964).

Studies were made on the influence and control of variables in fusion welding, leading to the development of an automatic program-control unit. Although the study is considered in the context of fuel-element end-seals, particularly with reference to argon-arc welding, the basic principles are applicable to other precision-welding requirements. The main factors to be considered in defining weld quality are specified, while the parameters influencing weld quality are classified into four major sections: material, joint details, welding equipment, and welding sequence. Control of variables is discussed in detail, examining the various methods available and leading to the control unit ultimately developed. This universal program-control unit, which can be used in conjunction with many types of power sources and manipulators, is described and its accuracy defined. Two methods of determining the weld program are available, either by plug board or punched tape; the relative merits of each are briefly considered. (P.C.H.)

6282 PREPARATION OF SINGLE CRYSTALS OF UO_2 BY SINTERING. Shoichi Nasu (Japan Atomic Energy Research Inst., Tokyo). Japan. J. Appl. Phys., 3: 664-5(Oct. 1964).

A sintering method for obtaining UO_2 single crystals of reasonable size and polycrystals of large grain sizes is described. The apparatus and the mechanism of the growth process are discussed. (C.E.S.)

6283 FABRICATION OF AMERICIUM–BERYLLIUM NEUTRON SOURCES USING A SYSTEM TO PREVENT CAPSULE CONTAMINATION. W. C. Mohr and J. A. Van Loon (Argonne National Lab., Ill.). Proc. Conf. Remote Systems Technol., 12th, San Francisco, 1964, 273-8.

Twenty-three americium–beryllium neutron sources and six americium–aluminum compacts containing a total of 8.8 grams of americium were fabricated. All of the operations, from mixing of the powders to seal welding and leak testing the loaded capsules, were done in a single special gloved enclosure. A knife edge seal was used during the powder loading and compacting operations in order to prevent contamination of the exterior of the capsule. (auth)

6284 METHOD FOR MAKING INEXPENSIVE THICK BORON TARGETS TO OBTAIN GAMMA RAYS FROM THE $^{11}B(p,\gamma)^{12}C$ REACTION. R. T. Santoro and H. Weaver (Oak Ridge National Lab., Tenn.). Rev. Sci. Instr., 36: 98(Jan. 1965).

A method is described for preparing targets from ordinary powdered boron, which have a long life and maintain a high gamma yield. (D.C.W.)

6285 DILUTION IN MULTIPASS WELDING AISI 4130 TO TYPE 304 STAINLESS STEEL. C. L. Estes and P. W. Turner (Union Carbide Corp., Oak Ridge, Tenn.). Welding J. (N. Y.), 43: 541s-50s (Dec. 1964).

The extent that dilution calculations are reliable for predicting the chemistry and ferrite content in each bead of a multipass weld was studied. The joint was comprised of AISI 4130 steel and Type 304 stainless steel with a backing ring of A106 Gr. B steel. The joint design was a U-groove filled with seven passes of Type 312 stainless steel filler metal. The weld was made automatically with the gas tungsten-arc process. Dilution calculations were used to predict the chemistry of each weld bead. A planimeter was utilized to measure the areas of relative amounts of base materials and preceding pass fused into beads. Each bead was chemically analyzed, and results were compared with calculated values. There was reasonably good agreement between analytical and calculated determinations, and percentage dilution decreased exponentially from the root to the face of the weld. The amount of carbide and ferrite formers arrived at by calculations was used to predict the percentage ferrite with the Schaeffler diagram. A ferrite gage and point counting were used to check these predictions. Calculated values were noticeably greater than measured values although the general trend in both cases indicated an increase in ferrite with successive passes. Variation in concentrations of chromium and nickel across weld beads was measured with an electron microprobe analyzer. Results clearly showed the absence of a concentration gradient across individual beads. Tensile properties along with Charpy V-notch data at room temperature and at −65°F are presented. The welding procedure is described. (auth)

6286 FABRICATION. Austin F. Reader, Edward F. Baehr, Walter E. Russell, and George Tulisiak (Lewis Research Center, Cleveland). p.5-32 of "NASA SP-5015."

Fabrication techniques and equipment used by NASA, DOD, and the aerospace industry in solving the problems generated by space-age hardware manufacture are described. (J.R.D.)

6287 FOUR-DIE SWAGER NOISE-REDUCING ENCLOSURE (Engineering Materials). (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). (CAPE-1166)

Five drawings are included. The enclosure consists of a fiberglass insulated box isolated from the floor and swager. The box has double front and rear doors and soundproof openings for feed and exit of materials to be swaged. Side walls are built from normal construction materials. Top and sides are sectionalized to facilitate easy disassembly for decontamination. Interior wall and ceiling linings adjacent to the loading doors are fabricated of solid sheet steel to prevent oil (thrown from the dies) from penetrating the insulation between the exterior and interior walls. The rear half of the interior walls and ceiling is fabricated from perforated sheet steel. The enclosure reduces the over-all frequency band level of 119 to 90 decibels. (P.C.H.)

6288 HIGH-PERFORMANCE CESIUM IONIZERS MADE FROM SIZED SPHERICAL TUNGSTEN POWDER. M. LaChance, G. Kuskevics, and B. Thompson (Electro-Optical Systems, Inc., Pasadena, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-692, 22p, $1.00. (CONF-640801-2)

From 4th Electric Propulsion Conference, Philadelphia.

Sized tungsten microspheres of ~3, 5 and 7μ mean diam-

eter were used to fabricate cesium ionizers having improved uniformity, pore character, and ionization performance. With particle size the only intended variable, a gradient series of 80%-dense porous structures was prepared. Fabrication procedures plus data on sintering rates, densities, permeability coefficients, mean pore sizes, pores/cm², spectrographic purity and cesium ionization performance are presented. Cesium ion current densities up to 60 mamp/cm² were achieved with 3- and 5-micron powder ionizers. The neutral fraction at 50 mamp/cm² was 1 to 3%, a considerable improvement over commercial tungsten and unsized spherical powder ionizers. The critical temperature was below Langmuir data for solid tungsten. Neutral fraction vs ionizer temperature curves for the 3μ experimental ionizers showed definite minima, and approximated the slopes predicted by the Saha-Langmuir equation for a work function of 4.6 to 4.8 ev. The neutral fraction and critical temperature decreased with pore size for these structures. Photomicrographs confirm that use of 3μ particles increased pores per unit ionizing area and reduced mean pore size (compared with use of coarse unsized microspheres). The fine spherical powder ionizers reached much higher current densities with lower neutral fractions than any other tungsten ionizers tested. (auth)

6289 ELECTRON-BEAM MELTING OF CERAMIC MATERIALS. A. Accary, A. Treillou, and J. Trouvé. 34p. (CONF-407-8).

From Electro Chemical Society, Toronto, May 1964.

Investigations showed that electron beam melting associated with continuous casting can be used for satisfactory fabrication of UC slugs. It is shown that slugs 30 cm long and 24 mm in diameter can be produced with an equiaxial structure, a carbon content controlled within a 0.1%, and oxygen and nitrogen contents as low as 600 ppm and 200 ppm, respectively. Description is given of the automatic apparatus used. Limitations of the method are an excessive volatility at high temperature under vacuum and an excessive brittleness. The production rate, which can be easily 6 to 12 tons/year, and the amortization cost, which is of the order of 20 F/per kg, were assessed. Attempts to generalize the method to other refractory materials, such as Al_2O_3, ZrO_2, UC_2, ThC_2, ZrC, and ThC–UC, are described. (P.C.H.)

6290 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL ELEMENTS. (to Commissariat à l'Energie Atomique). British Patent 971,930. Oct. 7, 1964. Priority date June 12, 1961, France.

The nuclear fuel pellets described are so shaped that they center themselves automatically upon introduction into a tubular sheath. The shape is generally cylindrical but with the two axial ends including a truncated conical part of male or female configuration so dimensioned that one may fit into the other of a similar pellet. A row of pellets of appropriate end configuration may thus be fitted together to form a composite substantially cylindrical fuel element. The method of manufabturing such pellets consists of preparing a granular mass from a powdered refractory fuel by mixing the powder into a binder, granulating in the cold the paste obtained, and drying and screening the grains. The granules are then compressed in a press provided with two stamps with appropriate truncated conical end parts, and the pellets are calcined in a reducing or inert atmosphere or in a vacuum. Various ways of stacking the pellets in a tubular sheath are illustrated. (A.G.W.)

6291 METHOD OF MAKING NUCLEAR FUEL COMPACT. Dale E. Johnson and Fred H. Lofftus (to U. S. Atomic Energy Commission). U. S. Patent 3,161,701. Dec. 15, 1964.

A method was developed for making high-temperature ceramic fuel bodies wherein a uniform distribution of fuel particles in a matrix material is accomplished. Compact, dense, particulate ceramic fuel particles of oxides, carbides, or silicides of nuclear fuel metal are admixed with and mechanically compacted with a wet paste comprising alumina, beryllia, aluminum carbide, beryllium carbide, and mixtures thereof; the mixture is dried and compressed and thereafter sintered to form a dense thermally conductive ceramic fuel body wherein the nuclear fuel is retained in particulate form. (AEC)

Properties and Structure

Refer also to abstracts 6142, 6171, 6414, and 6495.

6292 (ASD-TDR-62-719(Pt.II)) THERMAL RADIATION CHARACTERISTICS OF TRANSPARENT SEMI-TRANSPARENT AND TRANSLUCENT MATERIALS UNDER NON-ISOTHERMAL CONDITIONS. Robert C. Folweiler and William J. Mallio (Lexington Labs., Inc., Cambridge, Mass.). July 1964. Contract AF33(657)-11280. 147p. (AD-607742). $5.00(OTS).

Thermal radiation from refractory oxides is a volume rather than a surface phenomenon in the wavelength range 0.5–6 microns. Emissivity values have been calculated for specially prepared Al_2O_3, MgO, SiO_2, and $SrTiO_3$ samples from appropriate reflectivities, absorption coefficients, and scattering coefficients derived from material characteristics (index of refraction, single crystal transmissivity, pore size, and concentration). Experimental measurements of emissivity for these samples have been made at temperatures up to 1200°C and at wavelengths from one to fifteen microns. Calculated and measured values are in good agreement for Al_2O_3 and SiO_2. Absorption coefficients of the MgO and $SrTiO_3$ samples were greater than the single crystal values, leading to higher measured (than calculated) emissivities. Samples of commercial alumina had higher emissivities than the specially prepared high purity samples. The Hamaker equations for non-isothermal emissivity, which linearize the temperature gradient, have been compared with the exact solution by numerical integration. Results are in good agreement for all cases of practical interest for application to ceramic oxides. Solutions to the Hamaker equations have been derived for new boundary conditions. Evaluation of the rotating blackbody slot system indicates it gives results in good agreement with an external blackbody. An apparatus for measuring the effective emissivity of a non-isothermal sample has been constructed and tested. (auth)

6293 (BM-RI-6566) NICKEL–GADOLINIUM PHASE DIAGRAM. M. I. Copeland, M. Krug, C. E. Armantrout, and M. Kato (Bureau of Mines. Albany Metallurgy Research Center, Ore.). May 1964. 27p. Free(Bureau of Mines).

The investigation of the nickel–gadolinium phase diagram was undertaken to determine the alloying behavior of these two metals. The data from melting-point determinations, thermal analyses, metallographic examinations, and x-ray diffraction analyses revealed a phase diagram with three eutectic points and seven intermetallic compounds. Very limited solubility of the phases in each other was observed. The five phases, $Ni_{15}Gd_2$, Ni_7Gd_2, Ni_3Gd, Ni_2Gd, and $NiGd_3$, melted incongruently at about 1,300, 1,270, 1,180, 1,070, and 775°C, respectively. Ni_5Gd and NiGd melted congruently at approximately 1,550 and 980°C, respectively. Four of the compounds were determined to crystallize in the hexagonal system: $Ni_{15}Gd_2$, Ni_5Gd, Ni_7Gd_2, and Ni_3Gd. Ni_2Gd was determined to be cubic and NiGd, orthorhombic. The crystal system of $NiGd_3$ was not determined. The eutectic points occurred at 13, 67, and 85 wt pct gadolinium, and the isotherms at 1,290, 890, and 700°C, respectively. (auth)

6294 (HW-80309) THE EFFECTS OF HOT-WATER THERMAL TREATMENTS ON THE COLD WORK RECOVERY OF ZIRCALOY-2. A. L. Bement and J. E. Irvin (General Electric Co., Hanford Atomic Products Operation, Richland, Wash.). Oct. 1964. Contract AT(45-1)-1350. 40p. Dep.; $2.00(OTS).

The effects of thermal treatments at 360 and 425°C on the cold work recovery of Zircaloy-2 were determined from tensile properties. Specimens were taken from the rolling and transverse directions of cold-rolled plates containing 0, 10, 20, 40, and 70% cold work. The annealing temperatures represent those commonly employed for autoclave treatments given either fuel cladding or process

tubing before nuclear reactor service. Specimens containing 0, 20, and 40% cold work were also exposed in a hot-water loop at 282°C for times ranging to about 3500 hr to determine what property changes may result from thermal effects alone during long-term neutron irradiation in a hot-water environment. The specimens were given an autoclave treatment at 400°C prior to loop exposure. The following conclusions were reached from these studies: Substantial cold work recovery occurs in longitudinal specimens at both 360 and 425°C for all cold work levels. The response to recovery varies with testing direction due to variations in the modes of deformation resulting from crystallographic texture. Little recovery occurs in transverse specimens after a 360°C anneal. Recrystallization was not observed for any of the cold work levels after 72 hr at 425°C. Exposure at 282°C for as long as 3500 hr did not result in additional recovery beyond that caused by an initial autoclave treatment at 400°C. No pronounced aging effects resulted from any of the thermal treatments, and no yield point behavior was observed for any of the material conditions. There were, however, minor indications of strain-induced aging at 360°C in transverse specimens. Hydrogen content increased during loop exposure at 282°C according to the expression $C = 12.9t^{0.20}$, where C is hydrogen content in ppm and t is exposure time in days. Hydrogen concentration increased from 10 to 35 ppm with 3000 hr exposure. Although hydride platelets were observed to be oriented predominantly along the flow directions of prior deformation, neither this orientation nor hydrogen contents to 35 ppm affected tensile properties. The substructure appears to be formed within 10% cold work and retained in its essential features to higher levels of cold work. (auth)

6295 (KAPL-3032) EFFECT OF OXYGEN AND NITROGEN ON THE MECHANICAL PROPERTIES OF CONSOLIDATED ZIRCALOY-2 POWDER. P. T. Lovejoy, E. E. Baldwin, and K. Minassian (Knolls Atomic Power Lab., Schenectady, N. Y.). Aug. 25, 1964. Contract W-31-109-eng-52. 24p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The effects of oxygen and nitrogen additions on both long and short-time mechanical properties of consolidated Zircaloy-2 powder have been investigated. Tensile data have been obtained in the three principal directions of rolled plate and in the longitudinal direction of extruded sticks. The data indicate that oxygen and/or nitrogen additions increase strength and decrease ductility, as measured by reduction of area, in both short-time tensile tests and long-time creep tests. The interstitial oxygen effects diminish with increasing temperature and are negligible at or above 800°F. Oxygen additions are indicated by the data to be slightly more effective as a strengthener in rolled plate than in extruded stick. However, nitrogen additions are indicated to be 3 to 5 times more effective than oxygen as an interstitial strengthener. (auth)

6296 (KAPL-3062) THE FORMATION OF LARGE GRAINS IN ALPHA ZIRCALOY-4 DURING HEAT TREATMENT AFTER SMALL PLASTIC DEFORMATIONS. D. F. Washburn (Knolls Atomic Power Lab., Schenectady, N. Y.). June 1964. Contract W-31-109-eng-52. 30p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The formation of abnormally large grains during heat treatment of cold-worked Zircaloy-4 was investigated. Tensile samples, machined from plates of two different thicknesses, were strained at room temperature to elongations in the range of 2 to 12%. Small specimens, cut from the tensile samples, were annealed for times up to 165 hours at temperatures of 500, 600, 700, or 800°C. Abnormally large grains were observed to form at 800°C in specimens strained 6% or less. An incubation period for initiation of grain growth was required, which increased with decreasing strain. Moreover, the ultimate grain size increased with decreasing strain. At 700°C, the incubation period was markedly increased and at temperatures below 700°C there was no detectable change in grain size. The incubation period prior to the appearance of large grains was greater for specimens from the thick plate than for those from the thin plate. Furthermore, the maximum grain size in the thick-plate specimens was greater than that in the thin-plate specimens. The differences in behavior between the thick and thin plate were attributed to the small differences in initial grain size and to differences in the degree of preferred orientation. Based on light microscopy, it was found that in Zircaloy-4 with small degrees of cold work (12% or less) formation of a large-grain structure proceeds by the growth of existing grains rather than by the nucleation and growth of new grains. It was concluded that the only positive method of eliminating the formation of abnormally large grains during heat treatment after cold working is to insure that the cold work exceeds 10% or that the maximum heat-treatment temperature is less than 700°C. (auth)

6297 (ML-TDR-64-176) PROPERTIES OF ELECTRONIC AND MAGNETIC MATERIALS AT CRYOGENIC TEMPERATURES. J. G. Daunt (Ohio State Univ. Research Foundation, Columbus). Jan. 1964. Contract AF33(657)-10844. 9p. (AD-608041). $1.00 (OTS).

The work reported constitutes the initial stage of a program of investigation of the electrical, thermal, and magnetic behavior of Mo–Re alloys in their superconducting and normal states. This work covers data obtained on the electrical resistivity and thermal conductivity of Mo–Re (50% Re) wires as a function of magnetic fields at liquid helium temperatures. The magnetic fields used had intensities up to 50 kilogauss, produced by a superconducting solenoid. (auth)

6298 (MSAR-64-126) EFFECT OF HIGH-TEMPERATURE SODIUM ON AUSTENITIC AND FERRITIC STEELS. Progress Report No. 50. (MSA Research Corp., Callery, Penna.). Nov. 11, 1964. Contract AT(11-1)-765. 26p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The effects of air, helium, and high-carbon and -oxygen sodium at 1200°F on types 304 and 316 stainless steel and chromium-molybdenum steel are analyzed. Information is included on creep-rupture properties, fatigue, impact strength, corrosion, composition, testing, and ductility of the steels. (N.W.R.)

6299 (NAEC-AML-1759) THE HYDROGEN EMBRITTLEMENT SUSCEPTIBILITY OF A HIGH STRENGTH STEEL CONTAINING URANIUM. Edward J. Jankowsky (Naval Air Engineering Center. Aeronautical Materials Lab., Philadelphia). Sept. 25, 1963. 9p. (AD-421434). $1.10 (OTS).

An investigation was conducted to determine what effect the addition of uranium has on the susceptibility of high strength steel to hydrogen embrittlement. Based on the results of this investigation, it was concluded that the slightly better behavior of the uranium-bearing steel at high stresses is not great enough to warrant its use as a substitute for currently used steels. (auth)

6300 (NMI-7292) METALLURGICAL EVALUATION OF HIGH-URANIUM FUEL SYSTEMS. Final Report to Savannah River Operations Office, United States Atomic Energy Commission, Work Performed during the Period March–December 1962. R. W. Anderson (Nuclear Metals. Div. of Textron Inc., West Concord, Mass.). June 19, 1964. Contract [AT(30-1)-1565]. 63p. Dep.(mn); $3.00(cy), 2(mn) OTS.

A U alloy development program was conducted to develop high-U metallic fuel materials for power reactors. The alloys evaluated contained various combinations of Fe (to 350 ppm), Al (to 900 ppm), Si (to 1100 ppm) and Cr (to 500 ppm). The evaluations included studies of the microstructure and high temperature properties of the alloys in various metallurgical conditions. Particular attention was given to the thermal stability of the properties. The feasibility of fabricating fuel elements of the various compositions was explored. (auth)

6301 (NUMEC-3428-3) GROWTH OF SINGLE CRYSTALS OF PLUTONIUM. Quarterly Progress Report, July 1–September 30, 1964. (Nuclear Materials and Equipment Corp., Apollo, Penna.). Contract AT(30-1)-2389. 11p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Equipment and techniques for growing single crystals of alpha plutonium are described. (N.W.R.)

6302 (NYO-2994-3) SURFACE DIFFUSION STUDIES. J. B. Drew and J. J. Pye (Franklin Inst., Labs. for Research and Development, Philadelphia). Mar. 1964. Contract AT(30-1)-2994. 51p. (F-B1979-3). Dep.(mn); $3.00(cy), 1(mn) OTS.

The major accomplishments on a research program concerned with a study of surface diffusion phenomena on low index planes of face centered cubic metals are reported. Basic information relating to energies of activation, diffusional anisotropy, and the influence of gaseous atmospheres on the over-all kinetics was obtained. A quantitative autoradiographic technique was developed whereby accurate surface diffusion profiles can be obtained. A theoretical study was also made of the parasitic effect of volume diffusion at elevated temperatures. Extensive measurements were made of the Ni–Ag, Ni–Ni, Ag–Ag systems. Separate abstracts were prepared for two appendices. (auth)

For abstracts of individual sections see: 6303 and 6304.

6303 (NYO-2994-3(App.B)) SURFACE DIFFUSION MEASUREMENTS ON NICKEL SINGLE CRYSTALS. J. J. Pye and J. B. Drew (Franklin Inst. Labs. for Research and Development, Philadelphia). 12p.

The surface diffusion coefficients of ^{63}Ni diffusing over low index planes of Ni single crystals were measured. The measurements were made using a precision autoradiographic technique at 400 to 1000°C. The activation energy appears to be the same on the (111), (110) and (100) planes and amounts to 0.60 ev. This is in good agreement with the value (~.62 ev) reported for (111) planes obtained by mass transport techniques. (auth)

6304 (NYO-2994-3(App.C)) MATHEMATICAL TREATMENT OF COMPETITIVE SURFACE AND VOLUME DIFFUSION PROCESSES. Henri Amar (Temple Univ., Philadelphia) and James B. Drew (Franklin Inst. Labs. for Research and Development, Philadelphia). 10p.

A mathematical analysis of volume diffusion effects on high-temperature metallic surface diffusion is presented. (J.R.D.)

6305 (ORNL-3711) ACTINIDE DIFFUSION IN PYROCARBONS AND GRAPHITE. A Summary Report on Thin-Layer Experiments. R. B. Evans, III, J. O. Stiegler, and J. Truitt (Oak Ridge National Lab., Tenn.). Dec. 1964. Contract W-7405-eng-26. 93p. Dep.; $3.00(OTS).

An important phase of an experimental investigation of actinide migration in pyrolytic carbon has been completed. This work involved the determination of diffusion coefficients for thorium, protactinium, and uranium as a function of temperature by employment of the classical instantaneous-source-layer technique. The massive pyrolytic carbon investigated possessed a columnar microstructure composed of highly oriented turbostratic crystallites; such a structure leads to the unusual anisotropic characteristics associated with materials of this type. Thus determination of two sets of coefficients was required, one for diffusion perpendicular to the deposition plane (denoted as $D_\perp$), and another for diffusion parallel to this plane (denoted as $D_\parallel$). The experiments were designed to provide data over the temperature range 1000°C to 2400°C, which included three distinct migration regimes. Migration was found to be negligible below a threshold temperature of 1460°C. Above the threshold temperature—but below 1900°C—the migration could be described by applicable diffusion equations. At temperatures above 1900°C effects of structural changes, within the carbon matrix, intruded into the diffusion process such that the apparent coefficients decreased with increased diffusion anneal times. It was found, within the diffusion regime, that the diffusion behaviors of the actinides studied were similar. The ratio of coefficients, $D_\parallel/D_\perp$, was 280; the associated activation energy applicable to both directions was 60.8 kcal/g at. wt; values of the coefficients ranged from 10^{-7} to 10^{-12} cm^2/sec. Supplementary results obtained with porous-graphite specimens fell between the two sets of values obtained with pyrolytic carbon, with approximately the same activation energy. Several pyrolytic-carbon specimens were annealed (without actinide) for three hours at temperatures approaching 2900°C. Comparative examination of specimens before and after this annealing treatment indicated definite changes in specimen dimensions, crystallite sizes and orientation, and crystallographic parameters. All changes represented improvements in the carbon structure accompanied by decreases in defect concentrations. Actinides were immobile in the improved material produced via high temperature anneals. Accordingly, actinide mobility in as-deposited carbon was attributed, in part, to the defective structure of this material. Additional experiments at 2400°C revealed an arrested migration with respect to the $D_\perp$ direction. This finding, supported by structural characterization, demonstrated that drastic anneals and dramatic structural changes were not required to suppress actinide migration in the perpendicular direction. Extensive discussions have been prepared to complement this presentation of results. These discussions cover (1) motivations for conducting the studies, (2) applications of the results, (3) details of the diffusion experiments, (4) studies of carbon structures, (5) results of related investigations, and (6) speculations concerning the mechanisms associated with actinide migration. (auth)

6306 (TID-6728) FUNDAMENTAL ALLOY DEVELOPMENT. Quarterly Progress Report, August 1, 1959–October 31, 1959. Charles E. Lundin and Donald T. Klodt (Denver. Univ. Denver Research Inst.). Nov. 20, 1959. For General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati. Contract AT(11-1)-171, Subcontract AT-33. 33p. (XDC-60-9-72) Dep.(mn); $2.00(cy), 1(mn) OTS.

Embrittling factors in the hydriding and use of yttrium hydride were studied by microscope hot-stage and anneal-quench techniques. Data concerning the phase relationships in the yttrium-hydrogen system by the anneal-quench technique are presented. Specimens were hydrided at temperature and the formation of the hydride phase observed in the microscope hot-stage apparatus. The determination of the thermal expansivity of yttrium hydride was completed. The thermal conductivity of yttrium was obtained to 1650°F. The determination of the binary phase diagram of Y–Be was completed. Final diagrams of the systems Y–Re and Y–W are also presented. A tentative phase diagram of the Y–Ce system is presented. (auth)

6307 (LA-tr-64-30) SOLUBILITY OF URANIUM IN URANIUM MONOCARBIDE. A. Accary and P. Magnier. Translated by C. P. Kempter and Gretchen R. Riese (Los Alamos Scientific Lab., N. Mex.), from Journees Met. Automne, Oct. 14-18, 1963. 3p. Dep.(mn); $1.10(fs), $0.80(mf) JCL.

The solubility of uranium in UC was found to reach a maximum (2 at. %) at 1700 ± 30°C; it is very slight for temperatures lower than 500°C and in the region of 2200°C. No evidence was found for the solubility of carbon in UC. (D.L.C.)

6308 ORDERING IN BINARY σ PHASES. F. J. Spooner and C. G. Wilson (Royal Military Coll. of Science, Swindon, Wiltshire Eng.). Acta Cryst., 17: 1533-8(Dec. 10, 1964).

An x-ray-diffraction study was made of the ordering of atoms in the following binary σ phases: NbOs, NbIr, NbRe, MoOs, MoIr, and CrRe. Ordering of atoms among the different atomic sites was shown to exist in all cases. From these results and others it is deduced that the size of the constituent atoms is a major factor in governing the filling of A, B, and D sites but in addition some valency electron factor governs the filling of C and E sites. (auth)

6309 THE CRYSTAL STRUCTURE OF THE HIGH TEMPERATURE FORM OF NIOBIUM PENTOXIDE. B. M. Gatehouse (Univ. of Melbourne) and A. D. Wadsley. Acta Cryst., 17: 1545-54(Dec. 10, 1964).

High temperature Nb_2O_5 is monoclinic, space group P2, with fourteen formula units in the cell: a = 21.16, b = 3.822, c = 19.35 Å; β = 119° 50′. Twenty-seven of the Nb atoms are in octahedral coordination and one is tetrahedral. The structure contains ReO_3-type blocks of two different sizes. At one level these are three octahedra wide and five long, and are joined, by sharing edges on both sides, into slabs

running right through the structure in two directions. The second kind of block, three octahedra by four, cements these together by additional edge sharing, and leaves tetrahedral holes partly, but systematically, filled with niobium atoms. This form of Nb_2O_5 is the member n = 9 of a possible series of structural homologues $Nb_{2n+1}O_{5n-2}$. (auth)

6310 THE CRYSTAL STRUCTURES OF Nb_3Se_4 AND Nb_3Te_4. Kari Selte and Arne Kjekshus (Universitet, Oslo). Acta Cryst., 17: 1568-72(Dec. 10, 1964).

The compounds Nb_3Se_4 and Nb_3Te_4 are isostructural. The hexagonal unit cells have the dimensions: Nb_3Se_4: a = 10.012, c = 3.4707 Å; Nb_3Te_4: a = 10.671, c = 3.6468 Å. The space group is $P6_3/m$ (C_{6h}^2) and the unit cell contains 6Nb and 8Te(Se) in the positions: 6Nb in (h) ± (x, y, ¼; $\bar{y}$, x−y, ¼; y−x, $\bar{x}$, ¼) with x_1 = 0.4886, y_1 = 0.1039. 2Te in (c) ± (⅓, ⅔, ¾). 6Te in (h) with x_2 = 0.3389, y_2 = 0.2731. The relationships to the Ti_3Te_4 type structure of the Nb_3Se_4 and Nb_3Te_4 phases and the NbS_2 (H)-like structure of the $Nb_{1+x}Se_2$ phase are discussed. (auth)

6311 PRECIPITATION STRENGTHENING IN CRYSTALS OF ZIRCONIUM–HYDROGEN ALLOYS CONTAINING OXYGEN AS AN IMPURITY. D. G. Westlake (Argonne National Lab., Ill.). Acta Met., 12: 1373-80(Dec. 1964).

The critical resolved shear stress (CRSS) of crystals of zone refined zirconium was increased as much as 500% by hydrogen in the form of finely dispersed hydride needles. The combined strength increment due to hydrogen and the impurity, oxygen, is expressed by $\Delta\tau = (\tau_H^2 + \tau_O^2)^{1/2}$, where $\tau_O \simeq (A - BT^{1/2})^{1/2}$ and $\tau_H \simeq KG$ (A, B and K are constants and G is the shear modulus). Thus, the overcoming of oxygen barriers by glide dislocations can be thermally activated, but the overcoming of hydride barriers cannot. (auth)

6312 AN X-RAY DIFFUSE-SCATTERING STUDY OF THE Nb–Ti B.C.C. SOLUTION. P. S. Rudman (Battelle Memorial Inst., Columbus, Ohio). Acta Met., 12: 1381-8 (Dec. 1964).

By means of x-ray diffuse scattering, it was determined that Nb–Ti alloys exhibit clustering-type local order. The states of local order that have been determined in bcc Group-A alloys, Ti–Nb, Ti–Mo, and Mo–W, are compared and discussed in relation to phase diagram, solution thermodynamics, lattice parameter, and elastic modulus behavior. It is also shown that Fisher mechanism solution strengthening adequately accounts for the Nb–Ti alloy strength. (auth)

6313 THE BEARING OF NEUTRON SCATTERING DATA ON THE PAULING THEORIES OF TRANSITION METALS. W. Hume-Rothery (Oxford Univ.). Acta Met., 12: 1462-3(Dec. 1964).

The Pauling theories on transition metals are discussed. It is shown that the Pauling theory of a positive contribution of 0.22 μB for conductivity/atomic 3d interaction in iron is incorrect, and it is unlikely that any model is correct which gives Fe atoms in a state with a moment of exactly 2 μB. Of the Pauling approaches the view that in transition metals the bonding electrons are in hybrid spd states is the more probable. This was concluded from neutron scattering data on iron. (P.C.H.)

6314 HOT-PRESSED LEAD ZIRCONATE–LEAD TITANATE CERAMICS CONTAINING BISMUTH. Gene H. Haertling (Sandia Corp., Albuquerque, N. Mex.). Am. Ceram. Soc. Bull., 43: 875-9(Dec. 1964).

The properties of the lead zirconate–lead titanate solid solution system containing a 2 at.% Bi_2O_3 addition were investigated as a function of (1) composition and (2) hot-pressing temperature, time, and pressure. In general, the properties varied with composition in a manner similar to conventionally sintered ceramics. Optimum properties were found for composition 53/47 (Zr/Ti ratio) located at the morphotropic phase boundary between the rhombohedral and tetragonal ferroelectric phases. Results showed that hot-pressing temperature and pressure had the greatest effect on improving the properties, with time being slightly less effective. Grain size and bulk density were found to be related to temperature and pressure, respectively. Remanent polarization was shown to be a linear function of bulk density and an exponential function of grain size. (auth)

6315 INVESTIGATIONS ON THE SOLID STATE EQUILIBRIA IN THE SYSTEMS URANIUM–NICKEL–CARBON AND THORIUM–NICKEL–CARBON. Cesare Brisi and Pietro Appendino (Politecnico, Turin). Ann. Chim. (Rome), 54: 661-72(July 1964). (In Italian)

Solid state equilibria in the systems U–Ni–C and Th–Ni–C were studied. Metallic Ni is not stable in the presence of the U carbides. In Th-containing systems, Ni is not stable in the presence of ThC and ThC_2. ThC is stable, however, in the presence of Th_7Ni_3, ThNi, and $ThNi_2$; the compounds $ThNi_5$ and Th_2Ni_{17} are stable in the presence of elementary C. At least three ternary carbides may be formed in the central zone of the Th system. Samples were prepared from fine powders of the elements and heated in a furnace under vacuum or else in sealed quartz ampoules, from three to over 150 hours and from 880 to 1150°C. Data from spectrograms of the intermetallic compounds Th_7Ni_3, ThNi, $ThNi_2$, $ThNi_5$, and Th_2Ni_{17}, and the carbides $Th_2Ni_2C_5$ and $Th_2Ni_3C_2$, all using CuKα radiation, are tabulated. Three-phase regions were observed for Th_2Ni_{17}–Ni–C, $ThNi_5$–Th_2Ni_{17}–C, $ThNi_5$–$Th_2Ni_3C_5$–C and ThC_2–$Th_2Ni_3C_5$–C. A ternary diagram for the system Th–Ni–C is given. The reaction rates in the solid state between Ni and UC and between Ni and 50 mole % UC–ThC were examined. The reactivity between Ni and UC was small at 600°C, but increased greatly at 700 and 800°C. The rate of reaction between Ni and (U,Th)C at similar temperatures was greater. (BBB)

6316 THE SURFACE POTENTIAL OF OXYGEN ON URANIUM. J. C. Riviere (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Brit. J. Appl. Phys., 15: 1341-8(Nov. 1964). (AERE-R-4631)

The contact potential difference between ultra-high vacuum-deposited films of gold and of uranium was followed during the admission of oxygen. Taking the work function of gold as constant up to oxygen pressures of the order of 10^{-9} torr, and varying in a known fashion at higher pressures, the work function of the uranium film could be deduced for all conditions of oxygen coverage from nude to saturation, followed by subsequent re-evacuation to 5×10^{-9} torr. The outstanding result is that the surface potential is positive with respect to the clean metal at all coverages. In the region of initial adsorption, estimated surface dipole moments are so large as to indicate an ionic type of binding between oxygen and uranium. The surface potential changes during initial adsorption are interpreted in terms of penetration of oxygen atoms below the surface into two different types of interstitial hole in the uranium lattice, the larger being filled first. At higher pressures of oxygen, oxide formation is postulated, with the appearance first of uranium dioxide and then subsequently unidentified higher oxides, at the surface. The separation of a semiconducting oxide phase at the surface in fact explains the observation that the surface potential is at all stages positive, since an additional phase-boundary is introduced. An incidental result from the measurements is the average work function of vacuum-deposited gold films on aged polycrystalline tungsten, 4.714 ± 0.004 ev. (auth)

6317 CRYSTAL STRUCTURE OF THE COMPOUND $EuGa_3$. D. I. Dzyana, V. Ya. Markiv, and E. I. Gladyshevskii (Lvov State Univ.). Dopovidi Akad. Nauk Ukr. RSR, No. 9, 1179(1964). (In Russian)

An x-ray and microscopic examination of the alloy Eu–Ga showed that in the region from 60 to 90 at. % Ga four compounds exist: Eu_2Ga_3, $EuGa_2$, Eu_2Ga_5, and $EuGa_{3-5}$. $EuGa_2$ has the AlB_2 type structure ($P6/mmm$ — D_{6h}^1, a = 4.345 ± 0.003 Å, c = 4.520 ± 0.003 Å, c/a = 1.040). (auth)

6318 INFLUENCE OF IMPURITIES IN TANTALUM ON THE ELECTRICAL CHARACTERISTICS OF ANODIC TANTALUM OXIDE FILMS. R. H. Lorenz (North American Aviation, Inc., Los Angeles) and A. B. Michael. Electrochem. Technol., 2: 160-3(May-June 1964).

The influence of impurities in tantalum on the d-c

leakage, scintillation voltage, capacitance, and dissipation factor of anodic films was investigated for tantalum-base binary systems containing C, O, N, Fe, Si, Mo, W, Ti, Zr, Hf, or Nb at various concentration levels. Some ternary and quaternary tantalum-base systems containing Ti, Zr, and Hf were also investigated. Impurities in the substrate are characterized as having a strong, moderate or no influence on the electrical characteristics of anodic films. The most significant influences were observed with C, Zr, N, or O, for concentrations at which second-phase particles could occur in the substrate. It is proposed that the particles are the sources for faults in the anodic film resulting in a degradation of the electrical properties, particularly an increase in d-c leakage and to a lesser extent a decrease in scintillation voltage. The high scintillation voltages observed with some tantalum–titanium alloys suggests their use in electrolytic capacitors. (auth)

6319 MAGNETIC PROPERTIES OF Gd–Ce ALLOYS. V. I. Chechernikov and Iuliu Pop (Moscow State Univ.). Fiz. Metal. i Metalloved., 18: 363-7(Sept. 1964). (In Russian)

Temperature dependence of magnetic properties of Gd–Ce was measured. Constitution diagrams indicated a complex electron spiral configuration and hexagonal structure. It is shown that magnetic properties are related to the crystal structure. (tr-auth)

6320 EFFECTS OF RECRYSTALLIZING ANNEALING ON THE STRUCTURE AND PROPERTIES OF TANTALUM AND ITS ALLOYS. M. I. Gavrilyuk, V. B. Milova, and V. A. Konstantinov. Fiz. Metal. i Metalloved., 18: 389-95(Sept. 1964). (In Russian)

Effects of annealing temperature on the hardness, microstructure, and lattice parameters cast tantalum and its 10%-W alloys were analyzed. Metallographic, x-ray, and gas analysis indicate that increased hardness and reduced ductility after annealing, at certain temperatures are related to the redistribution of impurities within the grain. (tr-auth)

6321 X-RAY L-SPECTRA OF LANTHANUM ABSORPTION IN TETRA- AND HEXA-BORIDES WITH DEFECTIVE LATTICES. E. E. Vainshtein, S. M. Blokhin, and Yu. B. Paderno (Inst. of Inorganic Chemistry, Academy of Sciences, USSR and Inst. of Metal Ceramics and Special Alloys, Academy of Sciences, Ukrainian SSR). Fiz. Metal. i Metalloved., 18: 450-1(Sept. 1964). (In Russian)

Effects of boride lattice defects on the L_{III} x-ray absorption spectra in tetra- and hexa-borides were determined. The results showed that in a given group of borides the spectra exhibit no variations. (R.V.J.)

6322 SELF-DIFFUSION IN MOLYBDENUM. L. V. Pavlinov and V. N. Bykov. Fiz. Metal. i Metalloved., 18: 459-61(Sept. 1964). (In Russian)

Self-diffusion in molybdenum was studied at 2155 to 2540°C. (R.V.J.)

6323 THE STRUCTURES OF NIOBIUM AND TANTALUM PENTAFLUORIDES. A. J. Edwards (Univ. of Birmingham, Eng.). J. Chem. Soc.: 3714-18(Oct. 1964).

The pentafluorides of niobium and tantalum were found, by x-ray single-crystal techniques, to have a tetrameric structural unit in the solid. The metal atoms are at the corners of a square, linked by linear bridging fluorine atoms. The two compounds are isostructural with molybdenum pentafluoride. In each, the metal–fluorine bridging bond length is 2.06 Å and the metal–fluorine non-bridging bond length 1.77 Å. (auth)

6324 HEAT-TREATMENT OF ANODIC OXIDE FILMS ON TANTALUM. III. THE CONDUCTIVITY PROFILE. D. M. Smyth, G. A. Shirn, and T. B. Tripp (Sprague Electric Co., North Adams, Mass.). J. Electrochem. Soc., 111: 1331-6(Dec. 1964).

Dielectric measurements were used to study the distribution of the conductivity which is introduced into the anodic oxide film on tantalum by heat-treatment in air. The temperature and frequency dependences of capacitance indicate that the conductivity distribution is exponential with position in the oxide. The combination of these dependences yields an activation energy of 0.6 ev for the conduction process. The temperature and frequency dependences of tan δ for films which have been partially reanodized after heat-treatment also yield an activation energy of 0.6 ev. (auth)

6325 CONDUCTANCE DURING ANODIC OXIDATION OF TANTALUM AND NIOBIUM FILMS. C. L. White and W. E. Patterson (Texas Instruments Inc., Dallas). J. Electrochem., Soc., 111: 1336-9(Dec. 1964).

Conductance of tantalum and niobium films at room temperature is considered as a function of the forming potential of the anodic oxidation process. From elementary principles an equation was derived to relate metal film conductance to formation voltage. The equation indicates a linear relationship, and experimental measurements generally verify the linearity. Deviations of the characteristic from linear behavior were interpreted in terms of film sample and deposition parameters. Theoretical and experimental results suggest that the conductance-formation potential characteristic provides a fundamental tool for studying metal and oxide film parameters. (auth)

6326 STUDIES ON THE OXYGEN GRADIENTS IN OXIDIZING METALS. II. HAFNIUM. J. P. Pemsler (Kennecott Copper Corp., Lexington, Mass.). J. Electrochem. Soc., 111: 1339-42(Dec. 1964).

Coarse-grained hafnium samples were oxidized for times up to 432 hr. A remarkable anisotropy of the oxidation rate was observed which persisted to the thick film region. This effect is associated with a variation in the stoichiometry of the oxide films covering the differently oriented grains. The oxygen gradient beneath the oxide film was measured using a technique involving the rate of dissolution of interference colored oxide films. Experimentally determined gradients are in good agreement with a theoretical expression involving the diffusivity, time, and oxide film thickness. (auth)

6327 FORMATION AND COMPOSITION OF SURFACE LAYERS AND SOLUBILITY LIMITS OF PHOSPHORUS DURING DIFFUSION IN SILICON. E. Kooi (Philipps' Gloeilampenfabrieken: Eindhoven, Netherlands). J. Electrochem. Soc., 111: 1383-7(Dec. 1964).

A neutron activation analysis was used to study the behavior of phosphorus during its diffusion into silicon and silicon dioxide films. Certain correlations were found between the compositions of the oxide layers formed during the diffusions and the existing phase diagram of the system SiO_2–P_2O_5. In several experiments the concentration of phosphorus in silicon had reached the solubility limit, and a layer with very high phosphorus content was found to be present between the oxide film and the silicon substrate. (auth)

6328 SELF-GETTERING AND IMPURITY TRANSFER IN THE VAPOR DEPOSITION OF THORIUM BY THE CARBIDE IODIDE PROCESS. A. F. Reid (Commonwealth Scientific and Industrial Research Organization, Melbourne). J. Electrochem. Soc., 111: 1400-3(Dec. 1964).

The reactions of carbon monoxide, oxygen, and nitrogen at micron pressures with variously solid thorium tetraiodide, thorium carbide, and thorium nitride were studied in the temperature range 300–900°C, and found to display first-order kinetics. Activation energies for the reaction of oxygen and carbon monoxide with thorium carbide were 6 and 11 kcal, respectively. These studies combined with thermodynamic calculations show that in the carbide–iodide process for thorium deposition, suitable degassing of the thorium carbide feed and heating of the deposition vessel (containing thorium iodide) at operating temperature before the filament is heated will remove residual oxygen, oxides of carbon, and water vapor from the feed and from the vessel volume. Nitrogen can be removed before its reaction with carbide by degassing of the latter below 700°C. It was concluded that once deposition is begun, vapors subsequently outgassed from the feed or vessel will largely react with the heated thorium metal. Filaments containing 1 ppm of nitrogen and hydrogen, 9-13 ppm oxygen, and an estimated 3-6% of carbon were prepared. (auth)

6329 THE HIGH CARBON PORTION OF THE URANIUM–GADOLINIUM–CARBON SYSTEM. Terry C. Wallace, Nerses H. Krikorian, and Patrick L. Stone (Los Alamos Scientific Lab., N. Mex.). J. Electrochem. Soc., 111: 1404-8(Dec. 1964). (LADC-6115)

The high carbon portion of the uranium–gadolinium–carbon system was investigated using x-ray, thermal analysis, and chemical techniques. It was found that UC_2 and GdC_2 form a continuous series of solid solutions above 1525 ± 25°C with the exception of a narrow two-phase region [tetragonal-$(U,Gd)C_2$ + cubic-$(U,Gd)C_2$] lying along a line connecting UC_2 at 1785°C and approximately $(U_{0.8}Gd_{0.2})C_2$ at 1510°C. The $(U,Gd)C_2$ decomposition curve and the equilibrium associated with it were determined for the 1300 to 1525°C temperature range. The results at 1300°C show that the solid solution is still stable over the region from $(U_{0.12}Gd_{0.88})C_2$ to GdC_2. A lattice parameter curve is given for the quenched tetragonal-(U,Gd)C2 solid solution phase that varies continuously from a_0 = 3.522 A, and c_0 = 5.982 A at UC_2 to a_0 = 3.717 A and c_0 = 6.264 A at GdC_2. The solidus temperature decreased from 2475 ± 30°C for UC_2 to 2370 ± 30°C for GdC_2, whereas the eutectic temperature decreased from 2450 ± 30°C for UC_2 + C to 2310 ± 30°C for GdC_2 + C. The tetragonal to cubic transformation temperature of 1785 ± 20°C for UC_2 was found to decrease with the addition of GdC_2; likewise the tetragonal to cubic transformation temperature of 1275 ± 20°C for GdC_2 was found to decrease with the addition of UC_2. Because of the slow rate of decomposition of the solid solution compared to the time required to determine the tetragonal to cubic transformation temperature of single phased $(U,Gd)C_2$ samples, it was possible to determine the total transformation curve. A minimum was found at 1155 ± 20°C and a composition of $(U_{0.34}Gd_{0.66})C_2$. The course of the transformation curve was used to estimate the heat of transformation of tetragonal to cubic GdC_2 at 1275°C as 3.1 ± 0.5 kcal/mole and the change in the free energy of mixing in transforming from tetragonal-$(U,Gd)C_2$ to cubic-$(U,Gd)C_2$ solid solution as $\Delta F_M^{t\to c} = -x(1-x)\,[5{,}330 \pm 960 - (2.29 \pm 0.62)T]$ cal/mole, where x is the mole fraction of GdC_2 in the solid solution. (auth)

6330 ELLIPSOMETRIC INVESTIGATION OF THE OPTICAL PROPERTIES OF ANODIC OXIDE FILMS ON TANTALUM. S. Kumagai and L. Young (Univ. of British Columbia, Vancouver). J. Electrochem. Soc., 111: 1411-16 (Dec. 1964).

Tantalum surfaces were examined both immersed in the electrolyte and dry. The optical constants of the metal and of the oxide were obtained by comparing experimental and theoretical ellipsometer curves. It was found that the method of estimating the optical constants of the metal by neglecting the effects of the oxide film already present before anodization leads to serious error. The ellipsometric method gave results in agreement with those obtained using light polarized in the plane of incidence. The advantages of the method seem to lie in the investigation of films that are too thin or otherwise unsuitable for the spectrophotometric method, and for in situ measurements. (auth)

6331 THE EFFECT OF OXYGEN AND NITROGEN ON THE HAFNIUM $\alpha-\beta$ TRANSITION. N. H. Krikorian and T. C. Wallace (Los Alamos Scientific Lab., N. Mex.). J. Electrochem. Soc., 111: 1431-3(Dec. 1964).

The effects of oxygen and nitrogen impurities in addition to zirconium impurity on the hafnium metal transition temperature were investigated using a new, highly sensitive, and very versatile high-temperature thermal analysis apparatus. The results on hafnium $\alpha-\beta$ indicate that even small amounts of oxygen and nitrogen stabilize the α-phase, and that the transition is also dependent on the zirconium content. On the basis of the current interpretation of the best available data, 1740 ± 20°C is the most acceptable value for the $\alpha-\beta$ transition of pure hafnium. (P.C.H.)

6332 MAGNETIC SUSCEPTIBILITY AND ELECTRONIC SPECIFIC HEAT OF TRANSITION METALS AND ALLOYS. VII. Zr AND Rh METALS. Masao Shimizu (Imperial Coll. of Science and Tech., London and Nagoya Univ., Japan) and Atsushi Katsuki. J. Phys. Soc. Japan, 19: 1856-61(Oct. 1964).

The temperature variations of the electronic specific heats and the magnetic susceptibilities are calculated for Zr and Rh metals using the density of states curves determined from the low-temperature specific heat data for 4d-group transition metals and their alloys. The temperature variations of the electronic specific heats of these metals are well explained by the calculated results. The calculated values of the spin paramagnetic susceptibility without a molecular field are considerably smaller than the observed susceptibilities. For Zr metal the difference is mainly attributable to the orbital paramagnetism, and its orbital paramagnetic susceptibility is estimated to be about 1.0×10^{-4} emu/mole. From an analysis of the susceptibility in Rh metal, three possibilities are suggested to explain the experimental temperature variation of the susceptibility. (auth)

6333 PRECIPITATION OF ZIRCONIA PHASE IN NIOBIUM-MODIFIED CERAMICS OF LEAD ZIRCONATE–TITANATE. Takuro Ikeda, Yoichi Tanaka, Takako Ayakawa, and Haruo Noake (Nippon Telegraph and Telephone Public Corp., Tokyo). Japan J. Appl. Phys., 3: 581-7(Oct. 1964).

The piezoelectric performances of lead zirconate–titanate ceramics are much improved by an addition of niobia, and they are called the modified ceramics. Microscopic observation of these ceramics shows many pink precipitates segregating out of the grains. These parts are luminescent in the incidence of electron beams. The electron probe microanalysis reveals that they are rich in Zr and poor in Ti, Nb, and Pb. The amount of these parts increases with the addition of niobia. In the x-ray diffraction measurement, the lines characteristic to the baddeleyite-type structure become observable with increasing amounts of niobia, though much weaker than the perovskite-type spectra. These facts lead to the conclusion that a niobium ion occupies a Ti–Zr site by expelling out a zirconium ion and as a result, the modified ceramics consist of two phases, the baddeleyite-type zirconia phase and the perovskite-type solid solution phase. The latter has a composition $Pb_{1-x/2}\,((Zr_y - Ti_{1-y})_{1-x} - Nb_x)O_3$. The comparison of the physical properties of the solid solution ceramics with those of the modified ones gives further evidence for this expectation. (auth)

6334 AN IRON–CHROMIUM–ALUMINUM ALLOY CONTAINING YTTRIUM. C. S. Wukusick and J. F. Collins (General Electric Co., Cincinnati). Mater. Res. Std., 4: 637-46(Dec. 1964).

The development and properties of an Fe–25Cr–4Al–1Y alloy are reviewed. The mechanical properties are similar to those of ferritic stainless steels. The alloy consists of an Fe–Cr–Al matrix containing a dispersion of YFe_2. The dispersion inhibits grain growth but causes incipient melting at 2475°F. Yttrium improves the overall oxidation behavior as a result of improved surface oxide retention during cyclic testing. Kinetic data were obtained for the various reactions occurring during oxidation: weight gain, surface oxide growth, YFe_2 depletion, and internal oxidation. A mechanism for improved oxide adherence based on subscale effects is proposed. (auth)

6335 CONTRIBUTION TO THE STUDY OF THE DEFORMATION AND RECOVERY OF PURE BERYLLIUM. J.-M. Dupouy, J.-P. Poirier, J. Antolin-Beaudier, and Y. Adda (CEN, Saclay, France). Mem. Sci. Rev. Met., 61: 701-8(Oct. 1964). (In French)

The annealing and workhardening of beryllium was studied by transmission electron microscopy and by examination of the Kossel diagrams. It was found that annealing must be carried out above 1100°C in order to obtain appreciably improved grain. The lattice constants of beryllium were determined. (auth)

6336 DUCTILE BERYLLIUM COMES IN VIEW. Richard Schmidt (Bureau of Naval Weapons, Washington, D. C.). Metal Progr., 86: No. 6, 134-4; 136; 138(Dec. 1964).

Selective alloying and practices to promote fine grain

size are described as two promising methods by which the ductility of beryllium can be improved. Some of the phenomena that affect the deformation of beryllium single crystals are reviewed. The effects of crystal orientation, purity, hot working, and grain size are described. (M.C.G.)

6337 EFFECT OF PURIFICATION ON SOME MECHANICAL PROPERTIES OF BERYLLIUM. R. F. Bunshah (Univ. of California, Livermore). Metals Eng. Quart., 4: 8-17(Nov. 1964). (UCRL-7522)

The effects of purification on the mechanical properties of single crystals and polycrystalline material are critically reviewed. Comparisons are drawn between commercial-purity (99% Be) and high-purity (99.99% Be) material prepared by distillation and/or zone refining. In single crystals, purification decreases the critical resolved shear stresses for basal slip and prism slip, decreases the rate of work hardening, and, partially because of the foregoing factors, decreases the propensity for crack nucleation, either at inclusions or by the Stroh bend-plane splitting mechanism. Crack propagation is also made more difficult. The requirement of three-dimensional ductility of polycrystalline material as revealed by tensile and wide-sheet bend tests is discussed. A model is proposed for the attainment of useful three-dimensional ductility in wrought Be. This model does not require the activation of a nonbasal slip mode at room temperature for the attainment of three-dimensional ductility. (auth)

6338 THE CRYSTAL STRUCTURES OF U_2Fe_3Si AND TaNiAl. J. B. Kusma and H. Nowotny (Universität, Vienna). Monatsh. Chem., 95: 428-30(1964). (In German)

The systems U–Fe–Si and Ta–Ni–Al were studied by roentgenography at the cut 33 at.% U or Ta. Alloys were prepared by cold pressing and reaction in an H atmosphere at 1200–1400°C, and were homogenized at 1000°C (48 hours for Ta–Ni–Al) and 800°C (200 hours for U–Fe–Si) in sealed quartz ampoules. Powder patterns were recorded and evaluations of Debye-Scherrer plots using CrKα radiation are tabulated. The space group $P6_3/mmc$-D^4_{6h} is indicated by the data; a few very weak lines in the plot suggest the presence of a U oxide or Ta nitride. The lattice parameters in Å are: U_2Fe_3Si, a = 5.14, c = 7.71, c/a = 1.50; TaNiAl, a = 4.96, c = 7.98, c/a = 1.60. Thus these compounds would belong to the $MgZn_2$ type. To confirm this, the intensities of certain point positions were calculated. Statistical mixing of Fe and Si cannot be distinguished from ordered arrangements because of the U atom; the agreement with experimental values was good. The system U–Fe–Si is thus similar to other systems of two transition metals with Si in which phases of the $MgZn_2$ type are formed. In general, the addition of Si increases the total electron concentration; in Laves phases this causes a change from the $MgCu_2$ to the $MgZn_2$ type, as has been found in other systems. (BBB)

6339 THE H PHASES Ti_2TiC, Ti_2PbC, Nb_2InC, Nb_2SnC, AND Ta_2GaC. W. Jeitschko, H. Nowotny, and F. Benesovsky (Universität, Vienna). Monatsh. Chem., 95: 431-5(1964). (In German)

Suitable mixtures of components of each set of reagents were finely divided and sintered in sealed quartz vessels at 850°C for 600 to 900 hours; special cold pressing was needed for Ta_2GaC. The lattice constants for Ti_2TiC and Ti_2PbC are respectively: a, 3.15, 3.20 Å; c, 13.98, 13.81 Å; c/a, 4.42, 4.30; Roentgen density(ρ), 8.59, 8.49 g/cc. The constants for the Pb compound refer to the homogeneous region; for Ti-richer samples, the constants are 3.17, 13.98, and 4.40, respectively. The values were compared with those for analogous In, Sn compounds and with Nb_2InC (a = 3.17, c = 14.37, c/a = 4.53, ρ = 8.29), Nb_2SnC (a = 3.24, c = 13.77, c/a = 4.24, ρ = 8.37), and Ta_2GaC (a = 3.10, c = 13.57, c/a = 4.37, ρ = 13.01). Powder patterns of the Ti samples show in addition to the H phase slight traces of TiC; analysis of such a pattern of Ti_2PbC (CuK_α) is tabulated. Relatively short distances for Tl–Tl and Pb–Pb were noted in the Ti compounds; reasons for this phenomenon are suggested. Calculated intensities show best agreement for $(10\bar{1}5)$ and $(10\bar{1}\bar{6})$ on the assumption of $\Psi_{0.85Pb}$. A formula $(Ti_{1.97}Pb_{0.03})(Pb_{0.90}Ti_{0.03})C_{1-x}$ thus fits the data; similarly for the Tl compound. This explains the Pb–Pb distances, and the Tl–Tl; and also the greater Ti–C distance (2.16 Å; cf. Ti_2InC, 2.14; TiC, 2.16). (BBB)

6340 THE PHASES Nb_3Ga_2, Ta_3Ga_2, AND $Ta_5Al_3B_x$. H. Holleck, W. Rieger, H. Nowotny, and F. Benesovsky (Universität, Vienna). Monatsh. Chem., 95: 552-7(1964). (In German)

Analyses of powder patterns of each of the three compounds (CrK_α radiation) are given in tabular form. Gallides were prepared by heating the components, sealed in quartz ampoules, to about 950°C for 300 hours. Al–B alloys were prepared by hot pressing and were freed as usual, before homogenization, of the C-containing zone. Nb_3Ga_2 shows isotypic form with Ta_3Ga_2 and therefore belongs to the U_3Si_2 structure group. Its lattice constants are: a = 6.922; c = 3.500 Å, c/a = 0.505, density = 8.28 g/cc. Ta_5Ga_3 shows isotypic form with the Cr_5B_3 structure (T 2); this was deduced from comparison of calculated intensities with the similar system (T 2 phase) Mo–Si–B. Lattice constants are a = 6.58, c = 11.9 Å, c/a = 1.81, $\rho_{Roentgen}$ = 14.3 g/cc. Another phase similar to W_5Si_3 was found in this system. Addition of B to the Ta–Al system permits the formulation of a D 8_8 phase (Mn_5Si_3 type, partially filled). Comparison of the calculated intensity values for $Ta_5Al_3B_x$ with those of Hf_5Al_3 demonstrates the existence of this phase, with constants a = 7.78, c = 5.30 Å, and c/a = 0.681. D 8_8 phases were also found in the systems Zr–Al–B and Hf–Al–B, with formulas similar to the Ta compound. (BBB)

6341 INFLUENCE OF STRUCTURE ON MECHANICAL PROPERTIES OF PYROLYTIC CARBON. J. C. Bokros, R. J. Price, and T. A. Trozera (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nature, 204: 371-2(Oct. 24, 1964). (GA-5084)

An attempt was made to demonstrate how the mechanical properties of pyrolytic carbon deposited in a fluidized bed depend on its structure. Five different structures were obtained in a 2.5-cm diameter coater with a 15-g charge of spherical uranium dicarbide particles 150-250μ in diameter. Graphs illustrating the dependence of structural parameters and room-temperature mechanical properties on deposition temperature for pyrolytic carbon are presented. The anisotropy factor, apparent crystallite size, density, flexural modulus, and maximum fiber stress and strain at fracture are discussed. (C.E.S.)

6342 HIGH-TEMPERATURE CREEP OF NICKEL–TUNGSTEN ALLOYS (ON THE RELATION BETWEEN HIGH-TEMPERATURE CREEP AND DIFFUSION IN NICKEL-BASE SOLID SOLUTIONS. [PART] VI). Kaizo Monma, Hajime Suto, and Hiroshi Oikawa. Nippon Kinzoku Gakkaishi, 28: 304-7(1964). (In Japanese)

Tensile creep properties of nickel–tungsten alloys containing up to about 10 at. % tungsten were studied. Tests were carried out in an argon atmosphere over the temperature range from 750 to 1200°C, and the stress range from 1.4 to 9 kg/mm². Steady state creep rate ($\dot{\epsilon}_s$) decreased with the increasing tungsten content. Temperature and stress dependences of steady state creep rate were analysed using Dorn's equation, $\dot{\epsilon}_s = C\sigma^n \exp(-Q_s/RT)$. Activation energies ($Q_s$) were independent of applied stresses. They increased with the tungsten content from 66 kcal/mol for pure nickel to the maximum value of 84 kcal/mol for the alloy of 5 at. % tungsten, before they decreased with further increases of the tungsten content. Stress exponents (n) increased extremely with the tungsten content from a value of 5.0 for pure nickel to the maximum value of 7.2 for the alloy of 1.7 at. % tungsten. Whereas, in alloys containing more than this concentration of tungsten they decrease with the increasing content of tungsten to values less than that for pure nickel. (auth)

6343 TRANSMISSION ELECTRON MICROSCOPY OF MOLYBDENUM DEFORMED IN TENSION. Seiichi Karashima and Hiroshi Oikawa. Nippon Kinzoku Gakkaishi, 28: 426-31(1964). (In Japanese)

Dislocation configurations in a commercial molybdenum deformed in tension (1 to 11%) at various temperatures (to 700°C) were studied by transmission electron micros-

copy. Dislocations were usually joggy and nonuniformly distributed. Even at small strain many dislocation loops and cusps were observed. As the amount of strain was increased, dislocations became tangled and a cell-structure was clearly developed. The cell dimension seemed to depend neither on the amount of strain nor on the temperature of deformation. They had a size of 2 to 3 μ. Little changes in general features of dislocation arrangement occurred when the temperature of deformation was varied. With increases in the temperature of deformation, the average dislocation density decreased, while the dislocation density in cell walls remained nearly constant within the temperature range examined. A linear relation was found between the flow stress and the square root of the average and/or cell wall dislocation density at room temperature deformation. (auth)

6344 THE DEFORMATION OF POLYCRYSTALLINE TUNGSTEN AT 200°C. A. Wronski and A. Fourdeux (Union Carbide European Research Associates, Brussels). Phil. Mag. (8), 10: 969-78(Dec. 1964).

The strain rate sensitivity of the stress at the apparent proportional limit, σ_A, and the variation of dislocation density with strain were investigated for polycrystalline tungsten deformed at 200°C. The results are consistent with Hahn's theory of yielding and the dislocation velocities at σ_A evaluate to $\sim 10^{-4}$ and $\sim 10^{-2}$ cm sec^{-1} at strain rates of 1 and 50% min^{-1}, respectively. (auth)

6345 SPECIFIC HEAT OF LEAD AND LEAD ALLOYS BETWEEN 0.4 AND 4.2°K. B. J. C. van der Hoeven, Jr., and P. H. Keesom (Purdue Univ., Lafayette, Ind.). Phys. Rev., 137: A103-7(Jan. 4, 1965).

The specific heat of a pure single crystal and a pure polycrystalline sample of Pb was measured between 0.4 and 4.2°K. For the coefficient of the normal-state electronic term γ, a value of (3.00 ± 0.04) mJ/mole deg^2 was found. The value for the Debye parameter at 0°K, Θ_0, is 105.4 ± 0.8°K. Below 1.5°K, the superconducting-state specific heat C_s could be represented by a T^3 law, with a slope 5% larger than that of the normal-state specific heat C_n. As a result, below 1.5°K the superconducting-state electronic specific heat C_{es} followed a T^3 law, in disagreement with the exponential behavior predicted by the Bardeen-Cooper-Schrieffer theory. In an effort to investigate the anomalously large values of C_{es}, two samples of Pb alloyed with 1.76% In and 5.93% In were measured. For the 1.76% In sample the anomaly persists, but it disappears for the 5.93% In sample. Tentatively it can be concluded that energy-gap anisotropy is able to explain the lead results. (auth)

6346 FUSION CURVE OF CERIUM TO 70 KILOBAR AND PHENOMENA ASSOCIATED WITH SUPERCRITICAL BEHAVIOR OF FCC CERIUM. A. Jayaraman (Bell Telephone Labs., Inc., Murray Hill, N. J.). Phys. Rev., 137: A179-82(Jan. 4, 1965).

The fusion curve, the fcc-bcc transformation, and the γ-to-α Ce transformation were investigated at high pressures. The fusion curve exhibits a broad minimum located at about 33 kbar and 662°C and has an initial slope of −4.7°/kbar. The fcc-bcc boundary has an initial slope of −1.4°/kbar and meets the fusion curve at a triple point near 26 kbar and 674°C. The γ-to-α Ce boundary was delineated by following the resistance discontinuity and has a slope of 26.5°/kbar. The discontinuous resistance drop associated with this transformation progressively diminishes at higher temperatures, and above 545°K the resistivity is a smooth function of pressure. The fusion curve minimum is the result of a rapid density increase in the neighboring fcc Ce with pressure, due to a continuous transition from γ to α Ce (4f → 5d electronic promotion) along the extrapolated transition line, and reflects a P−V relationship in the solid typical of supercritical behavior. Thus, the fusion as well as the resistivity data lend strong support to the termination of the γ-to-α Ce transformation at a critical point, first proposed by Ponyatovskiĭ. The results of resistivity measurements suggest the coordinates 550°K and 17.5 kbar for the critical point. (auth)

6347 SIMPLIFIED APPARATUS AND TECHNIQUE FOR THE DETERMINATION OF CRYSTAL ORIENTATION BY ION BOMBARDMENT. R. L. Cunningham and Joyce Ng-Yelim (Dept. of Mines and Technical Surveys, Ottawa). Rev. Sci. Instr., 36: 54-6(Jan. 1965).

The ion bombardment camera, designed specifically for orientation determinations, is machined from clear acrylic plastic and incorporates an ion source of the glow discharge type. A plastic orienting sphere, illuminated from within, has engraved on it the low index directions of cubic crystals. Hemispherical collectors, bearing ejection patterns, are positioned on the sphere; and the orientation of the crystals may then be immediately observed. (auth)

6348 PHASE DIAGRAM OF THE MOLYBDENUM-RICH PORTION OF THE MOLYBDENUM–BORON SYSTEM. Yu-chih Chuang, Tsiang-lin Chuang, and Cheung-hang Wu. Sci. Sinica (Peking), 13: 1851-60(Nov. 1964).

The phase diagram of the molybdenum-rich portion of the molybdenum-boron system was studied. Micrographic analysis was employed as the principal method of investigation, supplemented by x-ray diffraction and incipient melting studies. The solubility of boron in molybdenum was found to be 0.2% at the eutectic temperature (2050°C) and 0.07% at 1400°C. The hardness of molybdenum decreases slightly with the increase of boron in the solid solution range, beyond which it increases steadily with further increase in boron content. (auth)

6349 NIOBIUM–GALLIUM SYSTEM. V. V. Baron, L. F. Myzenkova, E. M. Savitskii, and E. I. Gladyshevskii. Zh. Neorgan. Khim., 9: 2170-3(Sept. 1964). (In Russian)

Thermal, x-ray, and microstructure analyses were used for constructing the phase diagram for Nb–Ga alloy. (R.V.J.)

6350 CROSS SECTIONS OF W_2Zr–Mo_2Zr ALLOYS. E. M. Savitskii and A. M. Zakharov. Zh. Neorgan. Khim., 9: 2261-3(Sept. 1964). (In Russian)

Chemical composition, structure, and properties of W_2Zr–Mo_2Zr alloy in a tungsten–molybdenum–zirconium system were studied. Melting point, specific electric conductivity, hardness, and micohardness were determined for the alloys. (R.V.J.)

6351 THERMOEMISSION PROPERTIES OF SOME REFRACTORY COMPOUNDS ON METAL SUBSTRATES. T. L. Matskevich, T. V. Krachino, A. P. Kazantsev, and L. S. Markova. Zh. Tekhn. Fiz., 34: 2021-7(Nov. 1964). (In Russian)

The possible use of twelve refractory compounds on metal substrates as effective high-temperature emitters is considered. The diode used for measurement of the thermoelectric emission is described. Results are presented for ZrC, TaC, WC, VC, NbC, HfC, HfO_2, HfB_2, TaB_2, $(UC)_{0.2}$–$(ZrC)_{0.8}$, $(UC)_{0.08}$–$(NbC)_{0.92}$, and $(UC)_{0.2}$–$(TaC)_{0.8}$ on substrates of Ta, W, WC, and HfC. (M.J.T.)

6352 MATERIALS. S. S. Manson, G. Mervin Ault, Jack B. Esgar, Robert W. Hall, and John L. Shannon, Jr. (Lewis Research Center, Cleveland). p.33-63 of "NASA SP-5015."

A review of recent progress in space-age fabrication materials development is presented. Methods of improving material performance are discussed, and newer materials such as Be, Ti alloys, Ni alloys, Co alloys, and W alloys are examined along with pyrolytic graphite. (J.R.D.)

6353 LIQUID-METAL TECHNOLOGY. Louis Rosenblum (Lewis Research Center, Cleveland). p.97-103 of "NASA SP-5015."

In a review of liquid-metal technology it is pointed out that these materials can be employed as high-temperature heat-transfer and working fluids and in special electrical applications because of their large liquid range, stability, heat transfer characteristics, and electric properties. (J.R.D.)

6354 VYSOKOTEMPERATURNYE METALLOKERAMICHESKIE MATERIALY. (High-Melting-Point Metal-Ceramic Materials). G. V. Samosonov, ed. Kiev, Publishing House of the Academy of Sciences, 1962. 152p.

The physical properties and electronic structure of high-melting compounds of transition metals with B, C, N, and Si are considered. Classification principles for high-melting

compounds are surveyed. Results of studies of x-ray absorption and emission spectra of Ti, V, Cr, and Nb are given. Correlations between x-ray spectra and interatomic bonding in compounds are considered. Results of studies of electrophysical properties of high-melting compounds are presented. The properties of alloys of transition metals with one another are described. Nineteen articles are included; separate abstracts were prepared for 4. (M.J.T.)

For abstracts of individual papers see: 5912, 6355, 6356, and 6357.

6355 L SERIES OF NIOBIUM IN VARIOUS COMPOUNDS. M. I. Korsunskii and Ya. E. Genkin. p.36-9 of "Vysokotemperaturnye Metallokeramicheskie Materialy." Kiev, Publishing House of the Academy of Sciences, 1962. (In Russian)

Studies were made of the L_{β_2} and L_{γ_1} bands of Nb in NbN compounds with N concentrations of 6.32, 6.8, 8.1, 10.2, 11.9, and 12.6% and in Nb_5Si_3, NbC, NbB_2, and Nb hydrides The spectra were compared with the spectral contours in pure Nb. (M.J.T.)

6356 ELECTRICAL PROPERTIES OF RARE EARTH HEXABORIDES. G. V. Samsonov and Yu. B. Paderno. p.102-8 of "Vysokotemperaturnye Metallokeramicheskie Materialy." Kiev, Publishing House of the Academy of Sciences, 1962. (In Russian)

Electric resistance measurements on hexaborides of rare earth metals were performed by the usual compensation method using a KL-48 potentiometer. The dependence of the resistance of LaB_6 on porosity is given for porosities from 3.5 to 36.8%. The resistances of hexaborides and pure metals are given for La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu. Values of resistance and characteristic temperature of metals and hexaborides are correlated for Ca, Sr, Ba, La, Ce, Pr, Nd, Sm, Gd, and Yb. The variation of the resistance with the electron number is graphed. (M.J.T.)

6357 THERMOEMISSION PROPERTIES OF SCANDIUM AND GADOLINIUM BORIDES. G. A. Kudintseva, V. S. Neshpor, G. V. Samsonov, B. M. Tsarev, and Yu. B. Paderno. p.109-12 of "Vysokotemperaturnye Metallokeramicheskie Materialy." Kiev, Publishing House of the Academy of Sciences, 1962. (In Russian)

X-ray photographs were taken using powder on copper, to determine the phase state of the samples. The x-ray photograph of scandium boride showed the presence of ScB_2. The lines of the x-ray of gadolinium boride were explained assuming the presence of a mixture of two phases — GdB_6 and GdB_4. The experimental diodes used for the thermoelectric-emission studies are described. Emission characteristics and Richardson lines are given for the Sc and Gd boride samples and compared with previous values for LaB_6 and YB_6. (M.J.T.)

Radiation Effects

6358 (BMI-1701) IN-PILE FISSION-GAS RELEASE FROM URANIUM CARBIDE AND URANIUM NITRIDE. James B. Melehan and John E. Gates (Battelle Memorial Inst., Columbus, Ohio). Nov. 18, 1964. Contract W-7405-eng-92. 56p. Dep.; $1.50(cy), 1(mn) OTS.

In-pile fission-gas release behavior of cast $UC_{0.9}$, $UC_{1.01}$, $UC_{1.04}$, and $UC_{1.4}$, sintered $UC_{1.04}$ (93 per cent dense), and $UN_{1.01}$ (92 to 96 per cent dense) was studied at temperatures up to 1700°C. Fission-gas release from $UN_{1.01}$ was temperature-independent up to about 800°C. Above 800°C, release was temperature-dependent and could be described in terms of diffusion theory. Between 1000 and 1600°C, the diffusion coefficients for ^{133}Xe, ^{135}Xe, and ^{85m}Kr could be expressed by the relation $D = D_0e^{-Q/RT}$, where $D_0 = 3 \pm 2 \times 10^{-4}$ cm² per sec and $Q = 60 \pm 5$ kcal per mole. Limited data suggest that between 1000 and 1600°C the fission-gas diffusion coefficients in sintered $UC_{1.04}$ are comparable to those for sintered $UN_{1.01}$. Fission-gas release from the cast carbides was temperature-dependent between 1000 and 1600°C but never exceeded the theoretical recoil release. At 1600°C, the rate of fission-gas release in $UC_{1.01}$ and $UC_{1.4}$ was equal but at lower temperatures the release rate in $UC_{1.01}$ was higher than in $UC_{1.4}$. This higher release rate might be related to the presence of the interconnected UC_2 second phase in the $UC_{1.01}$ alloy. Definite values for the fission-gas diffusion coefficients in the cast carbides could not be determined because of the low rate of gas release. (auth)

6359 (CEA-R-2601) QUELQUES ASPECTS DU GONFLEMENT EN PILE DES MATERIAUX FISSILES. 1ÈRE PARTIE. URANIUM α NON ALLIÉ. (Some Aspects of In-Pile Swelling of Fissile Materials. 1st Part. Non-Alloyed α Uranium). Hubert Mikailoff (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). Sept. 1964. 50p. Dep.(mn).

An examination has been carried out of nonalloyed uranium samples, having various structural states, cold-worked and recrystallized, as-cast and β-treated, and irradiated at temperatures of between 450 and 600°C and with burn-ups from 1300 to 5500 Mwd/t. These samples swelled because of precipitation of the fission gases; the porosity thus produced has a morphology depending mainly on the type of deformation to which the metal has been subjected and which is due to in-pile growth. The most homogeneous distribution of pores, and thus that leading to the minimum swelling, is only observed in the material having a marked [010] texture in which the growth and perhaps the thermal cycling introduce little or no strain. For other materials the deformation/swelling association causes a more rapid destruction of the samples either by cracking when the deformation is due to twinning, or by pronounced swelling localized in the bands when deformation is due to slipping. Finally the fission-gas precipitation considerably facilitates, above 500°C, the germination and growth of the intergranular cracks which can then develop at low stresses. (auth)

6360 (FZK-188-2) MEASURED EFFECTS OF THE VARIOUS COMBINATIONS OF NUCLEAR RADIATION, VACUUM, AND CRYOTEMPERATURES ON ENGINEERING MATERIALS. VOLUME II. RADIATION-CRYOTEMPERATURE TESTS. Annual Report, November 9, 1962–April 30, 1964. E. E. Kerlin and E. T. Smith (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). May 1, 1964. Contract NAS8-2450. 307p.

A series of tests was performed to measure the combined effects of nuclear radiation and cryotemperatures on a group of nonmetallic spacecraft materials. This group consisted of materials classified as adhesives, seals, thermal insulations, electrical insulations, structural laminates, potting compounds, sealants, and dielectrics. Typical tests performed on specimens prepared from the materials included tensile-shear strength, leakage, ultimate tensile strength, ultimate elongation, stress-strain characteristics, thermal conductivity, pull-out strength of potted wire, and T-peel strength. Special test equipment allowed the specimens to remain submerged in liquid N_2 during irradiation and subsequently to be tested without interruption of the cryogenic environment. Measured properties of the materials as a function of integrated neutron flux and gamma dose are reported and recommendations for use of the various materials in applications associated with the test environments are made. (auth)

6361 (HW-82152) RADIATION EFFECTS IN SOME HANFORD REACTOR GRAPHITES. S. S. Jones and E. M. Woodruff (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 1964. Contract AT-(45-1)-1350. 52p. Dep.; $3.00(cy), 2(mn) OTS.

Results are presented of an investigation of the effects of long-term reactor irradiation (up to 16,000 Mwd/at.) on some physical properties of a group of nuclear graphites. The graphite types studied were CSF, KC, CSGBF, WSF, SGBF, and TSGBF. The physical properties investigated were (1) dimensions, (2) electric resistivity, (3) thermal resistivity, (4) apparent crystallite size, and (5) crystallite lattice spacings. It was found that specimens cut parallel to the extrusion direction exhibited only contraction occurring at a linear rate throughout most of the exposure period. Perpendicular specimens, on the other hand, showed

a small expansion initially, followed by a linear contraction in the later stages of exposure, but at a lower contraction rate than for parallel specimens. Electrical resistivity tended to saturate at very low exposures and the saturation level changed very little with further irradiation. Thermal resistivity also exhibited saturation but required higher exposures to reach a final saturation level. In marked contrast to the temperature independence observed for the electrical resistivity, the thermal resistivity was partially annealed and then returned to a second saturation level as a result of a 450 to 600°C temperature increase during the irradiation period. The apparent crystallite size in both the a direction (L_a) and the c direction (L_c) decreased substantially with exposure. L_a decreased more rapidly than L_c and no significant annealing effect resulted from the temperature rise during irradiation. Some evidence, however, for such annealing action was found for the crystallite c-spacing measurements. The c spacing increased with exposure while the a spacing decreased at a somewhat lower rate. Generally, the observations and conclusions from this study confirm the results of earlier investigations reported for lower doses. (auth)

6362 (HW-83164) POSTIRRADIATION EVALUATION OF ZIRCALOY-2 PRTR PRESSURE TUBES. PART II. M. C. Fraser (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 1964. Contract AT(45-1)-1350. 39p. Dep.; $2.00(cy), 1(mn) OTS.

Postirradiation evaluation of Zircaloy-2 PRTR pressure tubes has been underway for about 3 years. During that time, ten of the tubes discharged from the PRTR reactor have been destructively examined; burst testing has been the principal test method. Evaluation of the data from these tests indicates that the bursting strength and the circumferential elongation was influenced by fast neutron exposure, microstructure, and test temperature. It also indicates that the burst origin was more strongly influenced by fast neutron exposure than by flaws of up to 0.254 mm (0.010 in.) depth. For elevated temperature tests, the maximum fast neutron exposure of the specimens tested is about 7×10^{19} nvt, and for room temperature tests, the maximum fast neutron exposure of the specimens tested is about 4×10^{20} nvt. Unirradiated, the bursting strength for annealed specimens is about three to six times greater than design stress, 1012 kg/cm^2 (14,400 psi), depending upon bursting temperature. At the stated exposures, the bursting strength for annealed material is about four to seven times greater than the design stress. Similarly, irradiation of cold-worked material to the stated exposure has increased its strength from five to eight times the design stress to five to nine times the design stress. The bursting strength varied inversely as the test temperature; test temperature range was room temperature to 288°C (550°F). Room temperature test values of circumferential elongation have decreased with increased fast neutron exposure. Elevated temperature circumferential elongation values may have decreased with increased fast neutron exposure. Conclusions regarding changes in circumferential elongation from increasing amounts of fast neutron exposure are difficult because of the wide range in the values obtained. Flaw effective stress concentration values were obtained from 4 of the 24 tests. The maximum was 1.24 and the minimum was 1.04. The theoretical stress concentration factors for these four flaws were 1.4 (5E), 2.9 (6E), 4.8 (11C), and 6.5 (1C). Comparison of theoretical with effective factors indicates the tubes had low notch sensitivity. Burst testing will no longer be the principal test for postirradiation evaluation because of an increasing need for notch sensitivity and crack propagation tests. In addition, the burst strength data indicate that bursting strength of the irradiated PRTR tubes is not likely to be altered to dangerously low values within the next three operating years. (auth)

6363 (NAA-SR-Memo-9619) HYDROLYSIS OF AND FISSION GAS MEASUREMENT ON IRRADIATED URANIUM CARBIDE. E. W. Murbach, P. H. Shaw, and L. D. Hermo (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Mar. 24, 1964. Contract [AT-(11-1)-Gen-8]. 6p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The hydrolysis of UC samples from irradiation experiments AI 3-5 and 3-9 was studied, and an attempt was made to determine fission gas retention for these samples. It was found that UC irradiated to 10,000-15,000 Mwd/MTU does not hydrolyze appreciably in water; however it does hydrolyze in dilute nitric and dilute sulfuric acids. Fission gas measurements were inconclusive. Very little krypton was collected in the water hydrolysis experiments. It appeared that considerable fission gas was recovered from the samples hydrolyzed by dilute acid, but both traps ruptured before any quantitative data were obtained. (auth)

6364 (NP-14443) EFFECT OF NUCLEAR RADIATION ON MATERIALS AT CRYOGENIC TEMPERATURES. Quarterly Progress Report No. 14, April 1964–June 1964. (Lockheed-Georgia Co., Marietta, Ga.). Contract NASw-114. 46p. (ER-7352)

In-pile and out-of-pile screening tests on stainless steels and Ti alloys continued. Equipment performed satisfactorily during the period. An extended down time was utilized to complete major maintenance in the transfer system, test loops and refrigeration system. The investigation of the source of W in the reactor primary water system continued. The facility was improved by the addition of Al tread plate over the expanded metal grating above Quadrant "D". (auth)

6365 ON THE COLORATION OF IRRADIATED COBALT-GLASSES WITH ELECTRON BEAM. Mituo Ono, Shunkiti Hirokawa, and Hideo Nagai (Nagoya Univ., Japan). J. Phys. Soc. Japan, 19: 1985(Oct. 1964).

Cobalt glasses exposed to electron beams were observed to turn green, rather than grayish blue as in exposure to gamma radiation. The optical absorption coefficients of electron- and gamma-irradiated glasses were compared. The coefficients differed in the range of wave length from 450 to 500 mμ. The existence of an absorption band below 350 mμ was established. An explanation for the green coloration is proposed. (D.C.W.)

6366 PROBLEMS ARISING FROM THE USE OF SOME TYPES OF STAINLESS STEELS IN NUCLEAR REACTORS. G. Rossi and A. Cignolini (Centro Sperimentale Metallurgica Sezione, Genoa). Met. Ital., 56: 482-92(Oct. 1964). (In Italian)

Types and characteristics of precipitation hardened stainless steels, i.e., martensitic, semiaustenitic, and austenitic steels, which can be used in nuclear reactors, in mechanisms, as well as in stationary parts (vessel excepted) in which high mechanical resistance, corrosion and wear resistance, and strength are required are reviewed. Effects of neutron radiation on the mechanical properties, structure, and phase changes are considered in the light of theoretical considerations and on the basis of the latest results of experimentation. Melting problems, mass transfer, and phase precipitation, are also covered, with special emphasis on composition, unwanted impurities, and the latest melting technique required for purity and structural uniformity. (auth)

6367 THE CRYSTALLOGRAPHY AND BURGERS VECTORS OF DISLOCATION LOOPS IN α-URANIUM. B. Hudson (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phil. Mag. (8), 10: 949-60(Dec. 1964). (AERE-R-4609)

The orientation and Burgers vectors of the dislocation loops formed in α-uranium by neutron irradiation were determined. The loops lie on (010) and (100) with Burgers vectors $\frac{1}{2}\sqrt{(a^2 + b^2)}$ ⟨110⟩ and a [100] respectively. The loops are observed to lie in sheets, the loop planes coplanar with the sheet plane. The orientation of the two types of loops observed, and their Burgers vectors, are exactly as required to explain the irradiation growth phenomenon if the (010) loops are interstitial and the (100) loops vacancy. The arrangement of the loops in sheets, and the lack of mutual annihilation during annealing, can be explained in terms of the elastic interactions of the loops. (auth)

6368 INVESTIGATION OF SLOW NEUTRON SCATTERING ON IRRADIATED QUARTZ AND BERYLLIUM.

K. Baierlein (Technische Hochschule, Munich). Phys. Status Solidi, 7: 415-31(1964). (In German)

The change in the cross section $\Delta\sigma$, induced by neutron irradiation of quartz single crystals in a reactor, was determined for different neutron doses from transmission experiments with slow neutrons of wavelength λ in the range $5\ \text{Å} < \lambda < 12\ \text{Å}$. $\Delta\sigma$ was found to be strongly wavelength-dependent. Similar behavior was observed for non-irradiated quartz glass. It was suggested that in the crystal disturbed zones of glass-like structure are produced, with an estimated radius R of about 20 A. From the fact that the wavelength dependence of $\Delta\sigma$ did not change its form over a large range with increasing dose, it was concluded that these amorphous zones are formed directly, and not by an association of defects from different recoil cascades. Further transmission experiments were carried out with polycrystalline beryllium. (auth)

6369 INVESTIGATION OF THE YIELD REGION IN NEUTRON-IRRADIATED COPPER SINGLE CRYSTALS. III. THE CHARACTERISTIC SIZE OF THE SLIP BARRIER, ESPECIALLY THE ACTIVATION ENERGY. Ch. Schwink (Universität, Munich). Phys. Status Solidi, 7: 481-96(1964). (In German)

Previous experimental results allow a quantitative analysis to be made of the yield region of n-irradiated Cu single crystals. A study of the different parameters, especially the density of radiation-induced defects, leads to the activation energy U_0. With Seeger's potential, U_0 is found to be 2.6 ev for unannealed crystals (2×10^{18}nvt) at room temperature, annealing increases U_0 slowly to about 3 ev. For the higher annealed specimens, a new formula is required and is investigated in detail. The slope of the defect potential and the temperature dependence of the activation energy are discussed. (auth)

6370 EFFECTS OF α RADIATION AT LOW TEMPERATURE ON THE INTERNAL FRICTION OF VERY PURE COPPER. D. Koenig, J. Voelkl, and W. Schilling (Technische Hochschule, Munich). Phys. Status Solidi, 7: 577-90(1964). (In German)

A copper foil (purity 99.999%) of thickness 5 μm, which is fixed at one end, can be excited to perform transverse oscillations. Following irradiation at 30°K with α particles from a ^{210}Po-source the internal friction is studied as a function of temperature between 30 and 300°K, by measuring the decrease of amplitude. It is shown that after the irradiation the Bordoni peak is almost totally suppressed. After annealing at temperatures above 125°K the peak slowly appears again without reaching its original height even after annealing above 400°K. Each irradiation with following annealing reduces the total height of the peak. The well-known subsidiary peak disappears after the first irradiation. A series of other peaks (at about 39, 104, 170, and 240°K) is produced by the irradiation and may be probably explained by the interaction of dislocations with point-defects. (auth)

6371 EFFECTS OF α RADIATION AT LOW TEMPERATURE ON THE ELASTICITY MODULUS OF VERY PURE COPPER. D. Koenig, J. Voelkl, and W. Schilling (Technische Hochschule, Munich). Phys. Status Solidi, 7: 591-604(1964). (In German)

After irradiation at 30°K with α particles from a ^{210}Po-source a copper foil (purity 99.999%, thickness 5 μm, length 6 mm, breadth 2 mm) fixed at one end can be excited to perform transverse oscillations. The Young's modulus is determined from the oscillation frequency. A large decrease in the Young's modulus is found during irradiation, which tends to a saturation value of 18%. After heating to room-temperature the modulus rises again to its original value. The main annealing takes place within characteristic temperature ranges, which are identical with the well-known annealing stages of the irradiation induced electric resistance. The observed changes of the modulus cannot be explained by the interaction of point-defects with dislocations, but must be attributed to a bulk effect which involves the appearance of polarizable regions introduced by the elastic strain fields of interstitial atoms and vacancies. (auth)

6372 DILATOMETER FOR MEASUREMENT OF LENGTH CHANGES OF METALS WITH IRRADIATION. Klaus Isebeck (Technische Hochschule, Munich). Z. Angew. Phys., 17: 497-504(1964). (In German)

A dilatometer is described, with which the length changes of thin metal samples in irradiation can be measured. The metal samples are coupled mechanically to a condenser. Length changes caused by irradiation were reproduced by capacitance changes of the condensor. A sensitivity of at least $\Delta l/l = 10^{-9}$ could be achieved, and the constancy for all temperatures was better than $\Delta l/l = 10^{-8}$/hr. In the temperature region from −20 to 100°C a constancy of $^1/_{100}$ to $^1/_{1000}$°C was possible. A method for correction of thermally induced length changes, which appear during irradiation, was developed on the basis of a simple model and compared with experiments. The decay curve after irradiation could therefore be determined with increasing exactness. (tr-auth)

6373 DISPLACEMENT SPIKE CRYSTALLIZATION OF AMORPHOUS GERMANIUM DURING IRRADIATION. John Richard Parsons. Thesis, Chicago, Univ. of Illinois, 1964. 56p.

Thin films of metastable amorphous germanium (700 ± 100 Å thick), prepared by evaporation on rocksalt, were bombarded with either fast neutrons or monoenergetic Xe^+ ions at room temperature. Subsequent examination by bright and dark field transmission electron microscopy revealed that small discrete crystallized regions (ranging up to several hundred Å in size) were produced throughout the amorphous matrix by the irradiation. The fast neutron irradiation resulted in a linear increase in the density of crystallized regions with neutron doses ranging from 0 to 5.1×10^{16} n cm^{-2} and a most probable crystallized region size of 190 Å. The monoenergetic Xe^+ ion bombardment (covering a range of incident energies) resulted in a most probable crystallized region size very closely equal to calculated ion range for incident ion energies from 40 to 90 kev. Also, low (≤40 kev) and high (≥140 kev) Xe^+ ion energy cutoffs for the production of crystallized regions were observed. Other furnace annealing experiments with similar amorphous films showed that they crystallized completely near 400°C as a result of ordinary homogeneous heating. The results were explained on the basis of displacement spike crystallization, where the concentration of kinetic energy in the displacement cascade region was capable of inducing crystallization of the amorphous structure. A body of experimental evidence was presented, which indicated that the crystallization was confined to the displacement cascade region and therefore required the intense atomic agitation characteristic of the early stages of a displacement spike. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

6374 A THEORETICAL STUDY OF RADIATION DAMAGE IN ALUMINUM. Henry Domingos. Thesis, Seattle, Univ. of Washington, 1963. 109p.

A computer study was made of a model simulating a crystal of aluminum, in particular, phenomena of direct interest in predicting and explaining the behavior of aluminum during during and after exposure to various kinds of irradiation. First, a realistic potential interaction between two atoms is proposed. It is shown that this potential will account for many macroscopic properties such as the interatomic spacing, the sublimation energy, the elastic constants, the compressibility, the equation of state, and the volume dependence of the cohesive energy. This potential is used to study the lattice configurations and relaxation energies associated with point defects. The results show that the relaxation around a vacancy is non-radial, and that the energy of formation of a vacancy is 3.186 ev. Three types of interstitials are found to be stable: the split interstitial with an energy of formation of 2.676 ev, the site-centered crowdion with an energy of 2.710 ev, and the body-centered interstitial with an energy of 3.222 ev. Dynamic events are studied by giving one atom an initial velocity and calculating the forces produced on all atoms in the crystal. From the force the velocity and displacement after a time Δt can be cal-

culated. The resulting trajectories are plotted to show what would take place in a real crystal. It is found that the energy for migration of a vacancy is 1.13 ev. The energy for migration of a split interstitial is found to be about 0.35 ev. The threhold energy for creating permanent defects in a crystal is shown to be dependent on the crystallographic direction. The results are in good agreement with recent experimental results. (Dissertation Abstr., 25: No. 2 (Aug. 1964))

6375 PHOTOGRAPHIC EXPERIMENTS ON MELTDOWN OF IRRADIATED METALLIC URANIUM FUEL PINS. C. E. Dickerman and L. E. Robinson. 5p. (CONF-446-51).

From American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

Meltdown experiments on irradiated metallic uranium fuel pins were performed in the Transient Reactor Test Facility (TREAT) using recently developed equipment permitting behavior of elements exposed in an inert gas atmosphere to be recorded by high-speed color photography. Two Experimental Breeder Reactor II (EBR-II) and two Fermi Core A specimens were studied in order to observe directly the modes of failure and material motion. Photographs of each EBR-II sample showed the occurrence of preliminary failures, which were indicated by the release of small amounts of opaque vapor, before a single large failure with characteristic high-speed release of sodium which filled the capsule and prevented further observation. Fermi A pins failed, with the cladding cracking open upon expansion of the irradiated uranium at or near its melting point. Movement of fuel from the specimen which suffered extreme failure was accomplished by frothy globules, rather than molten streams issuing from small cladding cracks, as was the case for unirradiated samples. (P.C.H.)

6376 DISPLACEMENT EFFICIENCY IN IRON. J. R. Beeler, Jr., and D. G. Besco (General Electric Co., Cincinnati). 14p. (CONF-543-19)

From American Physical Society 1964 March Meeting, Philadelphia, 1964.

The reduction of damage production by all types of channeling is described, in a direct manner, by correlating knock-on atom trajectory geometry with damage production, as a function of primary knock-on atom (PKA) energy, in computer-simulated collision cascades. PKA with energies in the range 0.1 to 30 kev were considered. Computer memory limitations precluded computations for higher energies. At each energy, 16 PKA were started from a point midway between two normal lattice sites in a (002) plane, each atom being assigned a different randomly chosen initial direction. A second set of calculations was performed for the energy range 5 to 30 kev in which PKA were started from a normal lattice site. With one exception, the results obtained using a lattice site as a starting point were the same as those obtained using the midway starting point. The results indicate that K(E) is a monotonically decreasing function of PKA energy in an elastic collision cascade. (P.C.H.)

6377 PRIMARY DAMAGE STATE IN IRON. J. R. Beeler, Jr., and D. G. Besco (General Electric Co., Cincinnati). 21p. (CONF-543-17)

From American Physical Society 1964 March Meeting, Philadelphia, 1964.

The results of computer experiments on collision cascades in iron are discussed from the standpoint of the way in which the damage is distributed within a displacement spike. Special consideration is given to the unsaturated damage state produced by neutron irradiation. A few results on the nature of the saturated damage state are also presented. (P.C.H.)

METEOROLOGY

Refer also to abstract 6880.

6378 (SC-DC-64-1463) PARTICLE FALLOUT AND DISPERSION BELOW 30 km IN THE ATMOSPHERE. Final Report. K. D. Hage (Travelers Research Center, Inc., Hartford, Conn.). Aug. 1964. For Sandia Corp., Albuquerque, N. Mex. Contract [AT(29-1)-789]. 60p. Dep. (mn); $3.00(cy), 2(mn) OTS.

The mechanisms of transport and dispersion of aerosols and particles below 30 km in the atmosphere are reviewed in terms of their relative importance for the fallout of particles formed by reentry ablation processes. The results of numerous relevant experimental studies are briefly described and used to construct diagrams of residence time as a function of particle size and altitude, and of lateral cloud width as a function of particle travel time. A few calculations of surface deposit densities are included to show the transport and dispersion effects of altitude and particle-size variations in fall speed, and of lateral cloud growth in fairly typical observed wind fields of equatorial and polar summer and winter seasons. Some of the principal areas of uncertainty in fallout problems are described together with suggestions for computational studies and experiments that may improve the present capabilities for estimating peak concentrations, deposit densities, dosages, etc., and their probabilities. (auth)

6379 (JPRS-26742) METHODS AND INSTRUMENTS FOR METEOROLOGICAL OBSERVATIONS. Translated from Tr. Vses. Nauchn. Meteorol. Soveshch., 9: 1963. 144p. (TT-64-41999). $4.00 (OTS).

Twelve translated articles are presented which cover the following topics in meteorology and hydrometeorology; aerological observations, automation and data processing, radioisotope uses in hydrometeorology, particle analysis in clouds, raindrop size measurement, etc. A separate abstract was prepared of the article on radioisotope uses in hydrometeorology. (D.L.C.)

For an abstract of the individual section see: 6088.

PHYSICS

General

6380 (AD-608147) CURRENT SHEET TILT IN A RADIAL MAGNETIC SHOCK TUBE. Research Report 189. Rolf B. Johansson (Avco Corp. Avco-Everett Research Lab., Everett, Mass.). Sept. 1964. Contract AF49(638)-659. 19p. $2.00(OTS).

An experiment carried out in a radial (inverse pinch) shock tube with argon of 50 to 400 μ pressure and hydrogen of 100 μ pressure is described. The current sheet was found to be tilted so that the cathode side lagged the anode side. At the anode the shock has a tilt in the same direction as the current sheet. At the cathode the shock is normal. These phenomena can be correlated by physical models, which assume that the current is predominantly carried by the ions. (auth)

6381 (AFCRL-63-723) INTERACTION OF NEUTRAL ION STREAMS WITH A MAGNETIC DIPOLE FIELD. Scientific Report No. 197. J. W. Byrd (Pennsylvania State Univ., University Park. Coll. of Engineering). Oct. 20, 1963. Contract AF19(604)-4563. 86p. (AD-421518). $8.60 (OTS).

A macroscopic, non-viscous theory is used to study the transient behavior of a neutral ion plasma. Integral transform techniques are introduced to obtain closed-form solutions. The method is applied to two well-known problems to check its validity. The problem of a neutral ion stream flowing down the axis of a magnetic dipole field is then investigated with special emphasis on the transient behavior of the perturbation induced in the dipole. In addition, the calculation of the resulting velocity distribution is considered. (auth)

6382 (ANL-6914) DECOMPOSITION OF THE STATIONARY ISOTROPIC TRANSPORT OPERATOR IN THREE INDEPENDENT SPACE VARIABLES. Erwin H. Bareiss (Argonne National Lab., Ill.). Aug. 1964. Contract W-31-109-eng-38. 39p. Dep.; $2.00(cy), 1(mn) OTS.

Based on the idea of separation of variables, a decomposition of the three-dimensional linear transport operator is carried out, resulting in continuous sets of regular and generalized eigenfunctions. Because of the nonself-adjoint nature of this operator, the results could not be anticipated intuitively from the known decomposition of this operator in the special case of plane geometry. The results obtained may indicate a new approach to spectral theory. (auth)

6383 (NASA-TN-D-2554) MAGNETIC BREAKDOWN IN A FINITE ONE-DIMENSIONAL MODEL. Gabriel Allen (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Dec. 1964. 72p. $3.00 (OTS).

Exact solutions have been obtained for a model of an electron in a finite one-dimensional chain (20 atoms long) of "periodic" square wells acted on by a transverse uniform magnetic field. Eigenvalues and wave functions have been computed for several well depths and magnetic field strengths. Although the magnetic fields in the computations were of the order of megagauss and higher, it has been proved possible to associate these states with their zero-field counterparts. (auth)

6384 (NP-14508) THE DYNAMIC RESPONSE OF AN ELASTIC HALF-SPACE TO AN EXPLOSION IN A SPHERICAL CAVITY. Ari Ben-Menahem and Armando Cisternas (California Inst. of Tech., Pasadena. Seismological Lab.). [1957]. Contract AF49(638)-910. 32p. (VESIAC-2253-VU)

The radiation of seismic waves from a pressurized spherical cavity in an elastic half-space is studied. Spherical and cylindrical coordinate systems are set up at the center of the cavity and transformation to cylindrical waves is facilitated by employing a given operational representation for the spherical wave functions. A formal solution is obtained in the form of an infinite sum of branch-line integrals with a set of coefficients that depends on the radius and the depth of the cavity. A method is given for the evaluation of these coefficients to any desired degree of accuracy, valid for wavelengths longer than the linear dimension of the cavity, and for depths exceeding the radius of the cavity. The analysis is carried to a place from which numerical calculations can conveniently be applied. (auth)

6385 (NP-14534) TRANSPORT PROPERTIES OF HYDROGEN. Report No. 13. Dieter Brezing (Columbia Univ., New York. School of Engineering and Applied Science). Sept. 1964. Contract AF49(638)-1254. 72p.

The transport properties of hydrogen are calculated for a pressure range from 10^{-6} to 10^{2} atm, and at temperatures up to 10^{6}°K. The lower temperature limit is taken where the equilibrium gas mixture contains less than 1% molecular hydrogen. The Boltzmann formalism, which assumes binary collisions in the expressions for the transport properties of gas mixtures, is applied. Theoretical values, supported by experimental data whenever possible, are used for the atom-atom, atom-ion, and atom-electron collision cross sections. For Coulomb force interactions between charged particles, the Debye length is used as cutoff distance. The collision integrals for all interactions are computed. Values of viscosity, thermal, and electric transport coefficients, as well as the thermoelectric coefficients, are calculated. (auth)

6386 (NP-14546) NORMAL IONIZING SHOCK WAVES, THE EFFECTS OF EQUILIBRIUM, DISSOCIATION AND IONIZATION. Report No. 14. Robert Taussig (Columbia Univ., New York. School of Engineering and Applied Science). Aug. 1964. Contract AF49(638)-1254. 63p.

The steady state jump equations are solved numerically for plane, normal ionizing shock waves in an electromagnetic field. These solutions account for the effects of an upstream electric field parallel to the shock plane, and for the effects of dissociation and ionization across the shock front. Specific calculations are presented for diatomic hydrogen at 273°K and 100 microns Hg pressure with an applied magnetic field of 1.38 webers/m^2 perpendicular to the shock plane. The results are compared to corresponding ideal gas solutions, and basic differences in the downstream hydrodynamic variables between the gas and switch-on type shocks are discussed. Driving currents are computed for a shock wave followed by a current-driven rarefaction wave propagating down an annular shock tube. These computations compare favorably with previous experimental evidence, and confirm numerically analytic results of an approximate nature for hydromagnetic ionizing fronts. (auth)

6387 (NP-14569) LINEAR THEORY OF AN MHD OSCILLATOR. Research Report 198. James E. McCune (Avco Corp. Avco-Everett Research Lab., Everett, Mass.). Dec. 1964. 36p.

The linear theory of a-c fluctuations in an MHD channel subject to the Hall instability is explored. It is shown that the system as a whole (plasma, plus boundaries, plus external circuitry) is stable except at certain resonant acoustic frequencies. If these resonant frequencies are excited, channels of sufficient size can be made to oscillate and produce net a-c power. However, nonlinear effects limit the a-c power level severely for this geometry, and adversely affect the d-c performance of the channel. The analysis shows that resonant fluctuations can be controlled by external circuitry. (auth)

6388 (UCRL-7931) EXPERIMENTAL TECHNIQUES USED IN UNDERGROUND EQUATION OF STATE MEASUREMENTS. W. H. Gust and B. L. Hord (California. Univ., Livermore. Lawrence Radiation Lab.). July 15, 1964. Contract W-7405-eng-48. 29p. Dep.; $2.00(OTS).

Critical analysis of the geometric and operational char-

acteristics of a system used for making underground contained equation-of-state measurements is presented. Equation-of-state parameters for a well-known material were measured within uncertainties of less than 1 percent. Adequate shock pin reports were recorded for about 99 percent of the pins used. (auth)

6389 MAGNETOHYDRODYNAMIC STABILITY OF HETEROGENEOUS INCOMPRESSIBLE NONDISSIPATIVE CONDUCTING LIQUIDS. N. Rudraiah (Univ. of Western Ontario, London, Can.). Appl. Sci. Res., Sect. B, 11: 105-17(1964).

The flow of heterogeneous, incompressible, inviscid, perfect conducting liquids between two rotating or nonrotating coaxial cylinders is discussed. The stability of the liquid in question between two coaxial nonrotating cylinders with an applied magnetic field perpendicular to the flow is investigated. A sufficient condition for stability is found and if the motion is unstable an upper bound for the amplification factor is given. As a particular case the stability of the liquid with uniform steady velocity and with density varying as a function of a distance from the axis of the cylinders is discussed, and it is found that the effect of the magnetic field makes the flow more stable. The stability of the liquid in question between two rotating coaxial cylinders with an applied magnetic field in the tangential direction is discussed. A necessary and sufficient condition for stability is derived. The stability of the same liquid between two rotating coaxial cylinders with an applied magnetic field in the axial direction is treated. A sufficient condition for stability is derived. In general, it is inferred that in the case of parallel flow the magnetic field plays the same role in the liquid as gravitational field in Synge's discussion. (auth)

6390 MAGNETOHYDRODYNAMIC STABILITY OF HETEROGENEOUS DISSIPATIVE CONDUCTING LIQUIDS. N. Rudraiah (Univ. of Western Ontario, London, Can.). Appl. Sci. Res., Sect. B, 11: 118-33(1964).

The flow of heterogeneous, incompressible inviscid and conducting liquids between two nonrotating coaxial cylinders is discussed. The problem in question is investigated with an applied radial magnetic field. A sufficient condition for stability is found. In particular, if the steady flow velocity is uniform it is shown that the flow is always stable. The stability of homogeneous viscous conducting fluids through two fixed coaxial cylinders with an applied radial magnetic field was discussed. A sufficient condition for stability is derived and an upper bound for the amplification factor is given. The problem in question is treated with an applied axial magnetic field. A sufficient condition for stability is given, and some particular cases are investigated. (auth)

6391 X RAY SMALL ANGLE SCATTERING ON ISOTACTIC AND SYNDIOTACTIC POLYMETHYLMETHACRYLATE IN SOLUTION. W. Wunderlich and R. G. Kirste (Universität, Mainz). Ber. Bunsenges. Physik. Chem., 68: 646-52(1964). (In German)

The shape of the scattering curve of polymethylmethacrylate (PMMA) in solution is a function of the tacticity. The influence of a periodicity is apparent in the scattering curve of syndiotactic PMMA. A quantitative interpretation is possible by superimposition of a helical scattering curve on that due to a coil. Here H = 21, R = 4, and a = 13 Å (H and R are the identity period and the radius of the helix, respectively, and a is the persistence length of the coil) are assumed. The scattering curve of the isotactic PMMA shows nearly the course expected for coils. However a lower intensity is observed, which can be interpreted using plausible assumptions. The persistence length was also found to be a = 13 Å. The influence of the finite cross section of the tread on the scattering curve depends on the electron-density distribution within this cross section and on the electron density of the solvent. In the case of PMMA in benzene, the cross-section function can be set equal to unity for scattering angles up to $2\vartheta = 10°$. (auth)

6392 MULTIPLE SCATTERING OF 5-30 kev ELECTRONS IN EVAPORATED METAL FILMS. II. RANGE—ENERGY RELATIONS. V. E. Cosslett and R. N. Thomas (Cambridge Univ., Eng.). Brit. J. Appl. Phys., 15: 1283-1300(Nov. 1964).

The ranges of electrons in evaporated films of aluminum, copper, silver, and gold were measured for incident energies E_0 between 5 and 20 kev. From electron transmission measurements the maximum range and the extrapolated range were determined. Energy loss measurements gave the mean range and the Thomson-Whiddington range, corresponding to the mean energy E_m and the most probable energy E_p of the beam, respectively. The mean range, which is directly comparable with that given by the Bethe energy loss law, is found not to be identical with the maximum range. In view of its dependence on the experimental conditions, the maximum range appears to have little practical and no theoretical value, whereas the extrapolated range R_x is a reproducible quantity. The extrapolated mass-range ρR_x is proportional to $E_0^{\frac{5}{3}}$ and is almost independent of atomic number in the energy range studied. A relation between R_x and the Lenard absorption coefficient is found to exist. The Thomson-Whiddington constant does not have a unique value even for a given element at a given value of E_0 because the relation between thickness and E_p^2 is not linear for very thin films. The form of this relation agrees with that predicted by the Landau energy loss expression, but the experimental values of E_p are 25–30% below the theoretical values. A square law is, however, strictly valid for the mean energy E_m and gives an unambiguous definition of the range. Differences between the rate of fall of E_m^2 with thickness and that predicted by the Bethe energy loss law are qualitatively explained in terms of the variation of elastic scattering with Z and E_0. The mean energy loss is always greater than predicted by the Bethe law, whilst the most probable loss is less than predicted by the Landau expression and always much less than the mean loss. In the thinnest films the magnitude of the most probable loss is about 15% greater than that expected from the characteristic (plasma) energy loss; in thicker films it is three to five times greater. In general the differently defined ranges bear a simple relation to each other and to the ultimate range R_B found by integrating the Bethe energy loss expression, but departures from this scaling rule are found below 10 kev. Extrapolation of the (R_m,R_B) plot yields an intercept similar to that found in phosphors by Ehrenberg and King, but an order of magnitude smaller. The fact that both R_x and R_{max} are appreciably greater than R_B at low energies, especially in Al, is explained as due to the neglect of straggling of energy losses in deriving the Bethe expression. (auth)

6393 THE SEPARATION OF COHERENT AND INCOHERENT COMPTON X-RAY SCATTERING. W. Ruland (Union Carbide European Research Associates, Brussels). Brit. J. Appl. Phys., 15: 1301-7(Nov. 1964).

A theoretical and experimental study of the possibility of separating coherent and incoherent Compton x-ray scattering by monochromatization of the scattered radiation is carried out. It is shown that this possibility depends on the profile of the Compton line as well as on the resolution of the monochromator. An approximate treatment of the problem is developed and an application to carbon and organic materials is given. (auth)

6394 THE ABSORPTION OF X RAYS IN THE RANGE 7-17 Å BY Be, Mg, Al, Cu, AND Ag. B. A. Cooke and E. A. Stewardson (Univ. of Leicester, Eng.). Brit. J. Appl. Phys., 15: 1315-19(Nov. 1964).

X-ray mass absorption coefficients for beryllium, magnesium, aluminum, copper, and silver were measured using a 10 cm radius bent mica-crystal vacuum spectrometer. The x-ray detector was a thin plastic window, gas-flow proportional counter. An accuracy to about 1% was achieved and it appears that the commonly used values of Allen seriously undervalue the absorption in the region 7-17 Å. (auth)

6395 EXPERIMENTAL STUDY ON THE MÖSSBAUER EFFECT OF ^{57}Fe IN SEVERAL IRON COMPOUNDS. Takashi Nakamura and Sakae Shimizu. Bull. Inst. Chem. Res., Kyoto Univ., 42: 299-318(Sept. 1964).

The Mössbauer absorption spectra of some iron compounds were observed using the 14.4-kev gamma photons of ^{57}Fe. The quadrupole effect and isomer shift of $FeSO_4 \cdot 7H_2O$ were measured. The internal magnetic field in Fe_2B was also estimated. The effect of spin flopping at the Morin

temperature was confirmed for normal α-Fe_2O_3 (>1000 Å). The absorption spectra of ultra-fine α-Fe_2O_3 particles (about 50 and 150Å) were observed at 120 and 300°K, and no Morin transition was found above at least 120°K with such ultra-fine particles. The spectra of the particles of 50 Å taken at 120°K showed six-line splitting, while at 300°K showed only two lines. This phenomenon may be explained by a motional narrowing due to the rapid relaxation of antiferromagnetic spins compared with the nuclear Larmor precession (~10^{-8} sec). The critical volume of particles and critical temperature for this transition were found to be between 50 and 150 Å at 300°K and between 120 and 300°K for particles of 50 Å, respectively. It was also found that for ultra-fine particles the recoilless fraction would decrease from that obtained with larger particles. Three iron oxyhydrate isomers, α-, β-, and γ-FeOOH, were also used as absorbers and it was found that the Néel temperature for α-FeOOH may be close to 400°K and that for β-FeOOH may lie between 110 and 300°K, while γ-FeOOH is paramagnetic above at least 110°K. (auth)

6396 THE FREE, FLAT, TURBULENT JET IN THE PRESENCE OF A TRANSVERSE MAGNETIC FIELD. René Moreau (Université, Grenoble, France). Compt. Rend., 259: 2347-9(Oct. 12, 1964). (In French)

A class of solutions is obtained by making not very restrictive hypotheses on the laws of turbulent friction. These hypotheses contain, in particular, the Boussinesq form [$\tau = \rho\epsilon\ (\partial u/\partial y)$], but are more general. (tr-auth)

6397 BEHAVIOUR OF CHARGED POWDER IN MAGNETIC FIELD. Takuya Honma. Denki Shikensho Iho, 28: 281-3(1964). (In Japanese)

A theoretical treatment is given of general behavior of a charged powder in a gas with magnetic fields. As an example, it is shown that, in air having a temperature of 2000°K, the effect of magnetic fields with the intensity of several webers per square meter on the behavior of powder of 10^{-4} cm in diameter is negligibly small in comparison with the viscous effect of the surrounding fluid. (auth)

6398 THE THEORY OF SIMILARITY IN PULSED MULTITURN COILS. A. G. Limar and Yu. A. Litvinenko. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 344-8(1963). (In Russian)

The theory of similarity was used to simplify experimental investigations of the intensity of pulsed magnetic fields in multiturn coils cooled to low temperatures. Experimental results are reported for two coil configurations. (C.E.S.)

6399 A CONTRIBUTION TO THE THEORY OF RECOIL-ATOM BEHAVIOR. W. S. Diethorn (Pennsylvania State Univ., University Park). Intern. J. Appl. Radiation Isotopes, 15: 517-22(Sept. 1964).

Equations were derived for the distribution of recoil atoms and recoil energy in a flat-plate, recoil-atom source and in a target in contact with the source. An E^{-1} stopping power was assumed. The results should be useful in applications of alpha and fission sources. (auth)

6400 A NUMBER OF TECHNOLOGICAL PROBLEMS IN CARBON ION SOURCES. Ioakhim Vol'f. Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1423-6(Sept. 1964). (In Russian)

A graphite rod was heated to >2500°K by electron bombardment. Carbon ions were formed as a result of the collision of the electrons with the carbon molecules. The positive carbon ions were accelerated and withdrawn from the ionization region. A tungsten cathode was unsuitable as an electron source because of the formation of tungsten carbide, which was brittle and weak. It was found that at temperatures corresponding to an emission current density of 100 ma cm^{-2}, the length of service of a graphite cathode at 10^{-6} mm Hg std is about equal to the length of service of a tungsten cathode that is protected from reaction with carbon. Thermal evaporation determines the break-down of a carbon cathode, and reaction with oxygen limits the life of a tungsten electrode. Hence, a massive graphite cathode heated by electron bombardment was chosen for the carbon ion sources. The massive carbon rod was heated by electron bombardment (1500 V, 60 ma) to 2900°K to give carbon molecules by evaporation. The bombarding electrons come from another graphite tube heated to 2400°K by electron bombardment (~1500 V, ~220 ma) from an auxiliary tungsten cathode protected from the carbon vapor. The ion source was cooled by water, and gave carbon ion current of about 40 μa in a period of 1 to 2 hours. The amount of evaporated graphite was about 20 mg. Thus, the operating conditions were such that almost each 1000th electron created an ion, and almost each 1000th evaporated carbon atom was ionized. (TTT).

6401 NOISE TRANSFORMATION AND CYCLOTRON WAVES IN CROSSED FIELDS. J. E. Rowe and R. P. Wadhwa (Univ. of Michigan, Ann Arbor). J. Appl. Phys., 36: 9-14(Jan. 1965).

A transmission-line analog is developed for crossed-field space-charge flows from the simultaneous solution of Maxwell's equations, the Lorentz force equation, and the continuity equation. A thin one-dimensional injected beam is assumed. The resulting fifth-degree secular equation is solved for several values of ω_c/ω_p. The five system waves consist of a pair of hybrid waves, a pair of near-cyclotron waves, and a near-synchronous wave. The results indicate that noise transformers may be based on an equivalent piecewise uniform transmission line. (auth)

6402 RADIO-FREQUENCY BREAKDOWN IN A DC PARABOLIC POTENTIAL FIELD. Thomas W. Karras and Erick Lindman, Jr. (Univ. of California, Los Angeles). J. Appl. Phys., 36: 18-22(Jan. 1965).

Electrons that are confined in a Penning discharge geometry by electric and magnetic fields are observed to gain energy from a superimposed r-f field. By shaping the electrodes in the form of hyperboloids of revolution the pre-breakdown motion can be accurately described by the Mathieu equation. Resonances are predicted when the frequency of the electron in the electrostatic well is a multiple of half the r-f frequency. In the pressure range investigated (air at 10^{-2} to 10^{-5} torr), values as low as 40-v d-c and 3-v r-f were observed at the first resonance under conditions where the Penning mechanism alone required over 400-v d-c. Between resonances the Mathieu equation predicts runaway energy gain at considerably higher values of the r-f voltage, but breakdown is observed at values much lower than the prediction. The explanation is found in energy gain through collisions with gas atoms. The collision resets the phase of the motion and allows the electron to continually gain energy from the r-f field. Breakdown curves are calculated for the regions between resonances and are found to agree with experiment. (auth)

6403 POTENTIAL-WELL DESCRIPTION OF ELECTROMAGNETIC LEVITATION. Albert J. Hatch (Argonne National Lab., Ill.). J. Appl. Phys., 36: 44-52(Jan. 1965).

Levitational forces exerted by spatially nonuniform a-c magnetic fields on nonmagnetic conducting spheres are derived as the negative gradient of a potential function. Surfaces representing this potential for a small rigid diamagnetic sphere are used to visualize the levitational properties of several typical fields established by circular coils. Topological characteristics of these surfaces indicate that dipole fields have very shallow potential wells only for vertical and near-vertical positions of the coil axis, and are only marginally levitational. Helmholtz and mirror fields have similar shallow potential wells. Quadrupole fields, however, have deeper potential wells in the vicinity of the central nodal point for all positions of the coil axis, and are strongly levitational. Higher-order multipole fields can have potential wells similar to those in quadrupole fields. The description is also applicable to the levitation of nonmagnetic superconducting bodies in nonuniform a-c magnetic fields. (auth)

6404 STABILITY OF ARCS IN GASES. George A. Farrall and James D. Cobine (General Electric Research Lab., Schenectady, N. Y.). J. Appl. Phys., 36: 53-6(Jan. 1965).

A study was made to determine the average duration of d-c arcs in various gases at slightly higher than atmo-

spheric pressure. These arcs were drawn between ¾-in. copper contacts with power being supplied from a 125-v d-c generator. The experimental vessel, which contained about 1 liter volume, was provided with two liquid-nitrogen traps through which gas was admitted and withdrawn. The gases studied were hydrogen, helium, argon, nitrogen, oxygen, and sulfur hexafluoride. It was found that in the current range studied (about 1 to 45 amp) arc duration was always statistical and finite. This behavior is similar to that observed earlier for metal vapor (vacuum) arcs. For a given current, average arc duration increased for those gases in the order listed above. In the case of the latter two (O_2, SF_6), arc stability is believed to be strongly affected by arc reaction products. It was concluded that for each of the gases studied, arc duration was greater than that found for a copper vapor arc at the same current, using the same generator source. It is believed that the gases blanket the cathode surface during the arc and reduce the loss of metal vapor from cathode emission sites below that occurring in the vacuum arc. There was strong evidence in earlier work that abundant metal vapor at the arc cathode enhances arc stability. (auth)

6405 ELECTRON REMOVAL DURING THE EARLY OXYGEN AFTERFLOW. Michael H. Mentzoni (Sylvania Electronic Systems, Waltham, Mass.). J. Appl. Phys., 36: 57-61(Jan. 1965).

Microwave diagnosis showed that the early afterglow of an oxygen plasma was controlled by ambipolar diffusion and by recombination (α_r), depending upon pressure (from 0.15–4.0 mm Hg), at elevated gas temperatures (up to 900°K). At T_{gas} = 300°K attachment also seemed to be important for higher pressures (p > 0.65 mm Hg). For low plasma excitation energy the measurements yielded $\alpha_r = 2.1 \times 10^{-7}$ cm^3 sec^{-1} at T_{gas} = 300°K, dropping gradually to 1.4×10^{-7} cm^3 sec^{-1} at 894°K. The plasma excitation energy had a marked effect on the apparent recombination and attachment rates which tend to indicate that vibrationally excited ions and molecules do affect these rates as was suggested previously. (auth)

6406 ELECTRONIC PARTITION FUNCTIONS AT HIGH TEMPERATURES. Malcolm McChesney (Univ. of Liverpool). J. Appl. Phys., 36: 315-16(Jan. 1965).

Hester and Sewell (J. Appl. Phys. 35: 729(1964)) previously evaluated the thermodynamic properties of monatomic hydrogen and helium up to 10^5°K allowing for electronic excitation and ionization of the atom (and of the helium ion) by evaluating the translational and electronic excitation partition functions using cutoff procedures to prevent the divergence of the latter. The consistency of their physical model is questioned, and the electronic partition functions of neutral helium and xenon are considered. (C.E.S.)

6407 INFLUENCE OF SOURCE SYMMETRY ON CERENKOV RADIATION. Leon W. Zelby and James Vollmer (Radio Corp. of America, Camden, N. J.). J. Appl. Phys., 36: 322-3(Jan. 1965).

It is known that the contribution to the cyclotron radiation spectrum of N electrons moving in a circular orbit is cancelled up to the (N-1) harmonic if the electrons are symmetrically distributed over the circumference of the orbit and the separation between neighbors is equal to $(2\pi/N)$ rad. A possible analog of this phenomena in the case of Cherenkov radiation is investigated. To satisfy the conditions of Cherenkov radiation, charge velocity greater than the wavefront velocity is required. The case in which this condition is met but no radiation occurs is considered. (C.E.S.)

6408 INTERPRETATION OF THE ANOMALOUS SURFACE REFLECTION OF X RAYS. B. E. Warren and J. S. Clarke (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 36: 324-5(Jan. 1965).

When an x-ray beam falls upon a polished surface at an angle that is less than the critical angle θ_c, there is total external reflection. It was previously shown that for an incident angle greater than θ_c, there is not only the normal reflected beam at an angle equal to the incident angle, but also an abnormal beam at a smaller angle with the surface. An experiment with CuKα x rays falling on a Vycor glass mirror at angles of 1.5, 2.0, and 2.5 θ_c is discussed, and an interpretation of the anomalous reflection is given. (C.E.S.)

6409 FLUORESCENT PROPERTIES OF SOME EUROPIUM-ACTIVATED PHOSPHORS. A. Bril and W. L. Wanmaker (Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). J. Electrochem. Soc., 111: 1363-8(Dec. 1964).

The following europium-activated phosphors were prepared: gadolinium oxide, gadolinium borate, gadolinium phosphate, lanthanum borate, and europium phosphate. The phosphors show an emission spectrum characteristic of the europium. From the excitation spectrum of some phosphors it was deduced that energy absorbed by gadolinium ions can be transferred to the europium ions. Most phosphors have a relatively high brightness at elevated temperatures. Gd_2O_3–Eu has a rather high luminous efficiency with cathode-ray excitation. (auth)

6410 COORDINATES FOR THE STUDY OF PARTICLES TRAPPED IN THE EARTH'S MAGNETIC FIELD. A METHOD OF CONVERTING FROM B, L TO R, λ COORDINATES. Charles S. Roberts (Bell Telephone Labs., Murray Hill, N. J.). J. Geophys. Res., 69: 5089-90(Dec. 1, 1964).

A method is presented for converting from (B, L) to (R, λ) coordinates. (D.C.W.)

6411 SMALL-ANGLE SCATTERING OF LONG WAVELENGTH NEUTRONS AT DISLOCATIONS IN COLD-WORKED COPPER. J. Christ (Technische Hochschule, Munich). Phys. Status Solidi, 7: 557-76(1964). (In German)

An investigation is made of the small-angle scattering of subthermal neutrons (λ = 10 Å) at dislocations in Cu produced by cold-work at 78°K. The ϑ^{-3} dependence of scattering, calculated for a random arrangement of edge dislocations, is verified for polycrystalline samples. A dislocation density (L) of 8×10^{11} cm/cm^3 is deduced from the measured cross sections. The mean distance of two nearest dislocations is estimated from the deviations from the ϑ^{-3} dependence of scattering at very low angles to be about 540 Å. The azimuthal dependence of the scattered radiation, predicted by Seeger and Kröner, could be observed in small-angle scattering experiments on deformed mean-oriented single crystals if the direction of the incident beam is parallel to the glide plane. (auth)

6412 ELLIPTICAL POLARIZATION OF WEAK MAGNETOHYDRODYNAMIC WAVES. R. V. Doich. Rev. Roumaine Phys., 9: 181-9(1964). (In Russian)

Starting with the MHD equations and neglecting the wave damping, a study is made of the elliptic polarization of monochromatic MHD waves. It is shown that there exist, in general, three elliptically polarized waves, which, in the limit as $\omega \to 0$, reduce to linearly polarized waves. The propagation velocity and degree of elliptical polarization of these waves is studied. The problem is reduced to that of the rotation of the plane of polarization of a linearly polarized wave, parallel to an external magnetic field. The domain is described within which studies of monochromatic MHD waves, considering that they are plane-polarized and that associated shock waves are planar. (tr-auth)

6413 QUANTUM THEORY OF THE TRANSPORT PROCESS IN A MAGNETIC FIELD. [PART] II. J. Hajdu and S. Fischer (Universitat, Gottingen, Ger.). Z. Physik, 181: 479-93(1964). (In German)

Applying Kubo's formulas and damping theoretical arguments the electric, thermoelectric, and thermal transport coefficients for a system of free and independent electrons and fixed scatterers in the presence of an external magnetic field are calculated. Assuming δ-type scatterers it is shown that in the quantum region $kT \ll \omega \ll \zeta$ the Wiedemann-Franz law holds for the oscillating symmetric conductivities, whereas in the case of the antisymmetric ones quantum mechanical deviations from this law occur. For strong magnetic fields and arbitrary scattering potential the symmetric transversal transport coefficients can be expressed by Titeica type formulas. (auth)

6414 A POLYCRYSTALLINE X-RAY ANALYZING CRYSTAL. Max Canon (Thiokol Chemical Corp., Brigham City, Utah). 30p. (CONF-715-6)

From 13th Annual Conference on Applications of X-ray Analysis, Denver, Aug. 1964.

Analyses were performed to determine the feasibility of using pyrolytic graphite (PG) as an x-ray analyzing crystal. Pyrolytic graphite is formed by the pyrolysis of a hydrocarbon, which yields a hexagonal-structure graphite with a high degree of anisotropy. After annealing, the anisotropic properties are enhanced even more. For most applications, the intensity and resolution are not as good as the best analyzing crystals; however, the extreme durability of pyrolytic graphite makes it a feasible x-ray analyzing crystal. (auth)

6415 ACCELERATOR ELECTRODE CURRENTS IN ION ENGINES. David Moore and A. T. Forrester (Electro-Optical Systems, Inc., Pasadena, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-686, 42p, $1.00. (CONF-640801-3)

From 4th Electric Propulsion Conference, Philadelphia.

The "drain" currents from copper and ion accelerator electrodes (accels) of an ion engine were determined as functions of the cesium flux, accel temperature, ionizer-accel voltage difference and oxygen pressure. Three peaks are found in the drain current vs accel temperature curves. The low temperature peak (~300°C for neutral effluxes of 4×10^{15}/cm^2 sec) probably represents emission from Cs_2O. The middle peak (~500°C) is believed to be emission from a Cu–Cs surface, and the high temperature peak at about 700°C comes from a Cu–O–Cs surface. These peaks exist even under a total background pressure as low as 4×10^{-7} torr and are quite sensitive to small increases in the partial pressure of oxygen. Increasing the total pressure from 4×10^{-7} torr to 9.5×10^{-7} torr by bleeding in oxygen eliminates the central peak while increasing the height of the low temperature peak and the temperature of the high temperature peak. Increasing the cesium flux increases the height and temperature of the middle and high temperature peaks. The large "anomalous" Schottky effect found when the drain current is plotted as a function of the accel-ionizer voltage is believed to be a "patch" effect due to the surface consisting of patches of varying work function. (auth)

Accelerators

6416 (CEAL-1013) VACUUM DESIGN PROBLEMS OF HIGH-CURRENT ELECTRON STORAGE RINGS. G. E. Fischer and R. A. Mack (Cambridge Electron Accelerator, Mass.). Oct. 23, 1964. Contract [AT(30-1)-2076]. 35p. Dep.(mn); $2.00(cy), 1(mn) OTS.

The processes believed to be responsible for gas evolution in electron storage rings are investigated in some detail. It is shown how the rates may be combined to yield a quantitative gas load for a particular example. The results may aid in the design of systems of different materials and parameters. It is indicated how one might construct a ring vacuum system to deal with an expected operational gas load. It is concluded that the maintenance of adequate vacuum in a 3-Bev, 1-ampere storage ring is entirely feasible. (auth)

6417 (AERE-Trans-1014) THE IRRADIATION OF A TARGET INSIDE A CYCLOTRON. J. Andrade e Silva and G. Lochak. Translated by E. Billig (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.), from Nucl. Instr. Methods, 26: 22-6(1964). 21p. Dep.; $0.60(BIS); 3s. (HMSO).

A theoretical analysis of the energy distribution of particles captured by a target inside a circular accelerator shows that the target behaves as an energy analyzer. Furthermore it is shown that the energy of particles striking the target is the better known and of a lower mean energy as it is measured farther away from the internal edge of the target. This property allows the reduction of the uncertainty of energy on a part of the target, at the price of loss of radiation intensity. (auth)

6418 ACCELERATION OF PARTICLES BY MEANS OF LIGHT. Ya. B. Fainberg. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 300-18(1963). (In Russian)

A detailed review of the various effects that occur when charged particles interact with light is presented. The feasibility of accelerating charged particles with the aid of intense light beams produced by lasers is analyzed. To this end, the dynamics of particles accelerated by forces that are linear in the field intensity are considered, and it is shown that efficient acceleration is hindered by the fact that the ratio of the energy of the particle acquired over a distance on the order of the wavelength to the energy of the particle at rest, which is the governing parameter in the equation of motion of the accelerated particle, decreases by three or four orders of magnitude compared with ordinary accelerators. The conditions for synchronism between the particle motion and the wave, in order that the particle be continuously in the accelerating-phase region of the high-frequency field, are discussed. It is shown that heavy particles cannot be accelerated by a light wave moving with constant phase velocity at energies less than 10^{14} ev. In the case of electrons, however, the limit drops to 10^8 ev. Possible ways of maintaining the phase velocity constant with sufficient accuracy are discussed. The radial and phase stability are analyzed and the possibility of attaining simultaneous radial and phase stability considered. It is shown that variable-phase focusing and other types of dynamic focusing can ensure radial stability with the aid of high-frequency fields and also simultaneous phase stability, but the maximum attainable accelerated-particle density is much lower than can be obtained by usual phase focusing (10^{13}–10^{15} cm^{-3} for protons). It is shown further that when the accelerated particle moves in a medium, simultaneous radial and phase stability only can be obtained with the aid of the accelerating fields, and may be the most effective means in the case of acceleration of particles with the aid of light. Furthermore, the use of a gaseous medium can resolve the troublesome problem of the slow increase in the phase velocity of the wave along the accelerator, ensure synchronism, and eliminate the effect of the radially defocusing forces. An ionized gaseous medium, in conjunction with suitable choice of parameters, can make such a medium possess waveguide properties. (JPRS)

6419 BEHAVIOR OF CYCLOTRON HIGH FREQUENCY SYSTEM AT FREQUENCY VARIATIONS. I. Teodorescu (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 111-20(1964).

Certain aspects of the behavior of the high-frequency system of a variable energy cyclotron, when a relatively long line lies between the power generator and the dee system, was investigated. A method of dynamic adjustment was worked out to take into account the line effect, allowing optimum conditions for the acceleration and extension of the beam. It is suggested that frequency scanning used for the pulsing operation of the cyclotron can offer some advantages with respect to time stability and permit convenient pulse lengths. (auth)

6420 NEW METHOD OF OBSERVING THE PHASE OSCILLATIONS IN A SYNCHROTRON. Kenneth C. Crebbin (Univ. of California, Berkeley). Rev. Sci. Instr., 36: 64-5(Jan. 1965). (UCRL-11610)

A method of displaying the signal from a beam-induction electrode signal in a synchrotron is described. A dual-axis time display is produced by using a ramp and a series of trigger pulses, generated from the r-f, to produce a raster on an oscilloscope. The results give a picture that retains the details of a fast sweep and at the same time covers a relatively long time period. (auth)

6421 BEAM POSITION MONITOR FOR ACCELERATORS. Shigeru Okabe and Tatsuo Tabata (Radiation Center of Osaka Prefecture). Rev. Sci. Instr., 36: 97-8(Jan. 1965).

A monitor using four emitter foils that form an aperture is described. The secondary emission current produced by

intersection of part of the beam with one of the emitter foils is measured. (D.C.W.)

6422 AN ARRANGEMENT FOR EXPERIMENTS ON ELECTRON SCATTERING BELOW 60 Mev. F. Gudden, G. Fricke, H.-G. Clerc, and P. Brix (Technische Hochschule, Darmstadt, Ger.). Z. Physik, 181: 453-78(1964). (In German)

The facilities for electron scattering experiments at the Darmstadt electron linear accelerator (60 Mev at zero current) are described. They include an energy analyzing system with three 40° magnets and a 120° double focusing ($n = 0.5$) magnetic spectrometer. Spectra of electrons scattered inelastically from carbon are presented up to 20 Mev excitation energy. For the scattering peaks, total half widths down to about 100 kev are obtainable at 52 Mev. Energies of excited levels can be measured with an accuracy of ±10 kev in favorable cases. (auth)

6423 ON THE LONGITUDINAL STABILITY OF A CHARGED BEAM CIRCULATING IN A COAXIAL RESONATOR OF FINITE Q-FACTOR. A. N. Didenko and Yu. A. Salivon. Zh. Tekhn. Fiz., 34: 1979-85(Nov. 1964). (In Russian)

A study is made of the motion of an azimuthally homogeneous beam in a coaxial resonator, in which metal diaphragms are positioned along the side wall of larger radius. The conductivity of the resonator walls is considered finite, allowing the effect of finite Q on the charged-beam stability to be calculated. The dispersion equation is derived, and the results of a calculated solution are graphed. Curves are presented of the dependence of the region where increasing solutions of the equation are possible on the values of the spread of beam particles for subcritical and supercritical energies. (M.J.T.)

6424 STRONG FOCUSING IN HELICAL MAGNETIC FIELD. V. S. Zakharov and M. S. Rabinovich. Zh. Tekhn. Fiz., 34: 1986-91(Nov. 1964). (In Russian)

It is shown that a helical magnetic field can be used for focusing particles in accelerators. For a double-entering helical field the frequencies of free and phase oscillations and resonances are calculated, and approximations for the phase volume are presented. (tr-auth)

6425 CYCLE ACCELERATOR WITH 1-3 HELICAL MAGNETIC FIELD. V. S. Zakharov. Zh. Tekhn. Fiz., 34: 1992-7(Nov. 1964). (In Russian)

It is shown that a 1-3 helical field can be used for focusing particles in accelerators. Expressions for small betatron and phase oscillations are found, and approximations are presented for the phase volume. (tr-auth)

6426 THE USE OF FINE TUNING ELEMENTS IN A FOCUSING SYSTEM OF QUADRUPOLE MAGNETS. Yu. G. Basargin and N. I. Venikov. Zh. Tekhn. Fiz., 34: 1998-2002(Nov. 1964). (In Russian)

A focusing system is proposed consisting of two identical quadrupole magnets, excited from a single supply source, and of a fine-tuning quadrupole magnet with a supply source of significantly less power. Formulas are obtained for the computation of basic parameters and tolerances in instability of magnet excitation current for such a system. The basic advantage of the system over the usual doublet and the symmetrical triplet, described in the literature, is that the tolerances in instability of magnet excitation currents are substantially eased. (tr-auth)

6427 ACHROMATICAL ELECTROMAGNETIC QUADRUPOLE LENS WITH NONCOINCIDING FIELD DISTRIBUTION ALONG THE AXIS. E. V. Shpak and S. Ya. Yavor (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 34: 2003-7(Nov. 1964). (In Russian)

The effect of small deviations in the electric and magnetic field distributions on the performance of a combined quadrupole lens is considered, and it is shown that even for this case achromaticization of the image is possible. The condition of achromaticism of focus is derived in terms of the excitation values of the electric and magnetic lenses for various parameters of beam and lenses. (M.J.T.)

6428 SYSTEMS OF SERIES OF ELECTROSTATIC AND MAGNETIC QUADRUPOLE LENSES WITH NULL OR NEGATIVE CHROMATIC ABERRATIONS. A. D. Dymnikov and S. Ya. Yavor (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 34: 2008-14(Nov. 1964). (In Russian)

It is shown that the doublet of the quadrupole lenses can possess null or negative chromatic aberration in the focusing plane only in the case when one lens is magnetic and the other electrostatic, the magnetic lens gathering and the electrostatic scattering. A system of two such doublets with a predetermined choice of parameters gives an achromatic point image of a point object. (tr-auth)

6429 88 IN. CYCLOTRON (Engineering Materials). (California. Univ., Berkeley. Lawrence Radiation Lab.). (CAPE-1030)

Drawings (2057) are included for an 88-in., variable-energy, spiral-ridge cyclotron used in nuclear chemistry and in low energy physics research where variable-energy beams of a variety of ions are employed. The cyclotron will accelerate protons to 50 Mev, deuterons to 65 Mev, and heavier ions to corresponding energies. The radio-frequency has a range of 5.5 to 16.5 Mc/s and a working voltage of 70 kv dee to ground. Single dee construction permits operation in the third harmonic mode. The magnet has three flat hills on each pole which produce a maximum magnetic-field spiral angle of ~55°. Pole face windings are provided for trimming the magnetic field. (P.C.H.)

6430 IMPROVEMENTS IN OR RELATING TO LINEAR ELECTROSTATIC ACCELERATORS AND TO METHODS OF PRODUCING HIGH-ENERGY ION BEAMS. Frederick Arthur Julian and Anthony Christopher Riviere (to United Kingdom Atomic Energy Authority). British Patent 972,083. Oct. 7, 1964. Filed June 27, 1961.

An electrostatic generator has a positive ion source adapted to generate heavy molecular positive ions, which are filtered by a bending magnet and passed into a first tandem accelerator having a negative high voltage terminal. The negative terminal contains a gas target whereby at least a portion of the molecular ions disintegrate into fragments and the fragments pick up electrons to form negative ions. The negative ion beam is passed through a selector magnet and into a second tandem accelerator having a positive high voltage terminal. The positive terminal contains means for stripping electrons from at least a portion of the selected ions to form positive ions and for accelerating the positive ions beyond the terminal. (A.G.W.)

Astrophysics and Cosmology

Refer also to abstract 6600.

6431 SHAPE OF THE MAGNETOSPHERIC BOUNDARY UNDER SOLAR WIND PRESSURE. Ralph J. Slutz and James R. Winkelman (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 69: 4933-48(Dec. 1, 1964).

A theoretical solution is given of the boundary shape of a magnetosphere model in which the pressure of the magnetic field inside the boundary is balanced by the pressure of solar wind flow outside the boundary. A constant pressure is assumed in the wake of the solar wind flow, resulting in a model which is closed on the night side of the earth. The solution uses accurate rather than approximate equilibrium conditions, and thus gives an accurate solution of the model situation. The results show that the boundary on the night side is closer to the earth and fatter than was previously believed from qualitative considerations. The results compare well with the observations of Explorer 10, Explorer 12, and Explorer 14. (auth)

6432 LUNAR AND PLANETARY TAILS IN THE SOLAR WIND. E. G. Bowen (Commonwealth Scientific and Industrial Research Organization, Sydney). J. Geophys. Res., 69: 4969-74(Dec. 1, 1964).

It is hypothesized that at comparatively large distances downstream from the planets (distances comparable with the closest approach of Mercury to Earth or of Earth to Mars) the planets appear to cast shadow effects in the solar

wind. The hypothesis can be tested by direct measurements. (D.C.W.)

6433 IMPLICATIONS OF THE SOLAR-SYSTEM ABUNDANCES NEAR ATOMIC WEIGHT 90. D. D. Clayton (Rice Univ., Houston). J. Geophys. Res., 69: 5081-5 (Dec. 1, 1964).

The relative abundances of the elements Sr, Y, and Zr are good indicators of the distribution of neutron fluxes in stellar interiors. The simplest assumption of a monotonic spectrum of integrated neutron fluxes produces ratios near Sr : Y : Zr = 20 : 5 : 9.5. A smaller Sr/Zr ratio is shown to indicate a doubly peaked spectrum of neutron fluxes, an eventuality that is most easily interpretable as evidence of two distinct sources of neutrons for the s-process mechanism of nucleosynthesis. Calculations based on recent cross-section data indicate that the abundance of Zr cannot exceed that of Sr and that a Zr/Y ratio greater than about 2 appears to be most unlikely. (auth)

6434 THE SPECTRA OF THE SPATIAL FREQUENCIES OF THE RADIO BRIGHTNESS DISTRIBUTION OVER A COSMIC RADIO SOURCE. A. Z. Balklav (Astrophysical Lab., Academy of Sciences, Latvian SSR). Latvijas PSR Zinatnu Akad., Vestis, Fiz. Tek. Zinatnu Ser., No. 5, 19-30 (1964). (In Russian)

The spectra of the spatial frequencies of the radio brightness distribution over a real cosmic radio source in one and two dimensional cases are investigated. Expressions for the computation of the radio brightness distribution over a radio source are given in the case when the complex visibility method for the computation of the radio brightness distribution is compared with the aperture synthesis method. (auth)

6435 LITHIUM IN CAPELLA AND CONVECTIVE MIXING IN F AND G GIANTS. George Wallerstein (Univ. of California, Berkeley). Nature, 204: 367-8(Oct. 24, 1964).

On two spectrograms of α Aurigae the lithium line at λ 6707.8 was found to be much stronger in the F8 star than in the G5 component. The rough abundances of lithium in the two stars are derived. The implications of this difference are discussed with reference to stellar structure and evolution. Convective mixing is suggested as an explanation of the difference in lithium content. (C.E.S.)

6436 RADAR OBSERVATIONS OF THE CORONA AND MARINER II MEASUREMENTS OF THE FLUX IN THE SOLAR WIND. John C. Brandt (Kitt Peak National Observatory, Tucson, Ariz.). Science, 146: 1671-2(Dec. 25, 1964).

Radar observations of the corona can be used with a specified model of the corona to derive the particle flux in the solar wind at Earth. The most plausible model considered gives good agreement with the results obtained directly by the Mariner II plasma probe. (auth)

6437 A SURVEY OF SOLAR FLARE PHENOMENA. F. N. Byrne, M. A. Ellison, and J. H. Reid (Dublin Inst. for Advanced Studies). Space Sci. Rev., 3: 319-41(Oct. 1964).

A review is given of solar flare occurrence and importance, flare spectra, flare development and associated phenomena, flare theories, terrestrial effects of solar flares, sudden ionospheric disturbances, and solar particle emissions. A bibliography of 81 references is included. (C.E.S.)

6438 THE DYNAMIC EFFECT OF THE INTERPLANETARY MAGNETIC FIELD ON THE EARTH BOW SHOCK STAND-OFF DISTANCE. George L. Hand (Air Force Cambridge Research Labs., Bedford, Mass.). 19p. (CONF-471-51)

From American Physical Society 5th Annual Meeting, San Diego, Calif., Nov. 1963.

The presence of an interplanetary field not only provides the mechanism for forming a bow shock standing upstream from the geomagnetic cavity but also has a dynamic effect upon that bow shock. This effect is calculated for the simple case of solar wind velocity and interplanetary field being parallel. It is found that the bow shock stand-off distance is reduced below the no field case due to the existence of a $\vec{J} \times \vec{B}$ force in the shock layer which points toward the geomagnetic cavity. The stand-off distance depends on the density jump across the shock and the upstream Alfvén Mach number. (auth)

Atomic Physics

Refer also to abstract 6691.

6439 (AFCRL-63-697) PROTON AND ELECTRON SCATTERING BY DIATOMIC MOLECULES. Final Report. R. G. Greene, Jr. (Physical Studies, Inc., Centerville, Ohio). Apr. 1, 1963. Contract AF19(628)-476. 86p. (AD-421064). $8.10(OTS).

A brief introduction is given to the scattering matrix. The scattering of electrons by diatomic molecules, specifically oxygen, is discussed. The treatment is restricted in such a way that electronic computing machinery is not requisite to the final solution. In the electron case the Born approximation is applicable. The proton-molecule scattering problem is discussed, specifically proton scattering by oxygen. A distorted wave treatment is carried to the point where a very small set of one-dimensional differential equations are obtained. Then the impact parameter treatment of this same proton-oxygen problem is considered. For the familiar two-state case the total cross sections are obtained. (auth)

6440 (COO-1277-7) ANGULAR AND ENERGY DISTRIBUTION OF ELECTRONS FROM GASES IONIZED BY PROTON IMPACT. Technical Status Report No. 6, August 1, 1964–October 31, 1964. M. Eugene Rudd and Carl L. Bailey (Concordia Coll., Moorhead, Minn.). Nov. 1, 1964. Contract AT(11-1)-1277. 9p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Electron ejection from excited states in helium and neon by hydrogen molecular and proton bombardment is analyzed. Cross sections for ionization of gases by proton impact are being evaluated. (N.W.R.)

6441 (JINR-P-1779) KVAZIKLASSICHESKOE PRIBLIZHENIE V ZADACHE DVUKH TSENTROV. (Quasiclassical Approximation in Two-Center Problem). S. S. Gershtein, L. I. Ponomarev, and T. P. Puzynina (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Joint Inst. of Theoretical Physics). 1964. 19p. Dep.(mn).

The problem of two Coulomb centers is treated in the quasiclassical approximation. The interpolation formulas, which are valid at any distance between the centers, were obtained, as have expressions for the wave functions. The comparison with the results of the exact calculation shows that the quasiclassical approximation is effective, even for the terms with small quantum numbers. (auth)

6442 (AD-602146) IMPROVED EXPRESSIONS FOR THE MATRIX ELEMENTS OF OPERATORS OF SPIN-DEPENDENT INTERACTIONS. A. P. Jucys, R. S. Dagis, Ya. I. Vizbariate, and S. A. Zhvironaite. Translated by Robert Magruder and Stuart W. Kellogg (American Meteorological Society, Boston), from Lietuvos TSR Mokslu Akad. Darbai: Ser. B, 3: 53-66(1961). 20p. $1.60 (OTS).

Inaccuracies are indicated in the expressions for two-electron matrix elements of spin interaction in previous works. Definitions of radial integrals are presented which express the energy of these interactions between the electrons in an atom, and establish their characteristics. Tables are presented, which can be employed to find the correct expressions for the matrix elements of the energy of spin interactions for a number of configurations. (auth)

6443 ENERGY LOSS OF FAST IONS (80 kev) OF LITHIUM AFTER COLLISION WITH RARE GAS ATOMS. Michel Barat, Jacques Baudon, and Albert Septier (Faculté des Sciences, Orsay, France). Compt. Rend., 259: 2397-2400(Oct. 12, 1964). (In French)

The experimental results concerning the discrete losses sustained by rare gas ions crossing targets of rare gas atoms were previously reported. In order to be able to make certain comparisons, Li^+ were used as projectiles on targets made of rare gas atoms. The curves obtained

with lithium resemble very closely those obtained with He^+ crossing the same gases. (tr-auth)

6444 ANHARMONICITY CORRECTION AND POTENTIAL CONSTANTS: BH_4^- ISOTOPIC IONS. K. Venkateswarlu and M. Radhakrishnan (Kerala Univ., Alwaye, India). Czech. J. Phys., 14: 848-50(1964).

Normal coordinate analysis for XY_4 type molecules of T symmetry was carried out by the Wilson F–G matrix method. Making use of the spectral data the anharmonicity factors for $B^{11}H_4^-$, $B^{11}D_4^-$, $B^{10}H_4^-$ and $B^{10}D_4^-$ were calculated, and potential constants were evaluated for borohydride isotopic ions. (auth)

6445 INVESTIGATION OF A SUPERSONIC FLUX OF CARBON DIOXIDE GAS USED AS A TARGET FOR ION RECHARGE. E. S. Borovik, F. I. Busol, V. B. Yuferov, and E. I. Skibenko. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 283-94(1963). (In Russian)

Research to develop a hydrogen-cooled magnetic trap and produce intense beams of fast neutral hydrogen or deuterium atoms is described. On the basis of cryogenic methods it is proposed to use as charge-exchange targets supersonic jets of gases such as CO_2, N_2, O_2, Ar, and H_2 flowing in vacuum and completely condensed on a cooled surface. The experiments reported were made with carbon dioxide. The main parameters of a supersonic jet of this gas are first derived, after which the experimental setup, the test procedures, and the results are described. The investigations give grounds for assuming that in spite of the fact that the gas was not fully condensed and that an inverse flux of CO_2 molecules was observed, the use of carbon dioxide as a charge-exchange medium is feasible particularly if the purity of the gas and the pumping-on rate are increased. The possibility of the maximum amounts of carbon dioxide that can be frozen on the condenser and the possibility of constructing a closed-cycle system are also discussed. (JPRS)

6446 STUDY OF SUPERSONIC FLOW OF NITROGEN AND ARGON. E. S. Borovik, F. I. Busol, and V. B. Yuferov. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 294-9(1963). (In Russian)

Supersonic jets of argon and nitrogen were tested, and the condenser was cooled to hydrogen temperature. In addition, in the setup it was possible to protect the working volume of the trap against the entry of jet molecules by an absolutely black channel, constituting a tube cooled to low temperature. The experiment demonstrated the feasibility of the use of hydrogen cooling for the development of supersonic gas target jets, and that no additional technical problems arise in this connection; in fact, the vacuum can be improved somewhat. The experiments also showed that tubes which are cooled with liquid hydrogen or liquid helium are practically absolutely black to the molecules of all gases with sufficiently low vapor tension at the corresponding temperature. It is suggested that in conjunction with effective pumping methods this method of protection will find application in thermonuclear and other devices where large pressure drops are necessary in high or superhigh vacuum. (JPRS)

6447 THE THERMOELECTRON EMISSION OF A NUMBER OF MATERIALS IN CESIUM VAPOR. S. Ya. Lebedev and Yu. Ya. Stavisskii. Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1499-1503(Sept. 1964). (In Russian)

Samples of W, Mo, Ti, Ta, C, Re, Ni, Nb, Hf, Zr, and 18-8 stainless steel were heated over the range of temperatures from 18 to 1000°C at Cs vapor pressures of 10^{-2} to 10^{-6} mm Hg std. The electron current as a function of 1/T was plotted, and values of A and the work function $\phi_{opt.}$ at optimum surface coverage are given. The optimum work function $\phi_{opt.}$ for tungsten was in good agreement with the value given by Taylor and Langmuir in Phys. Rev. 44: 423(1933) The formation of an optimum coating led to a decrease in work function ($\Delta\phi \sim 3.0$ ev). Values of $\phi_{opt.}$ and of A respectively are 1.07 ev and 0.10 for Ti, 1.11 ev and 0.15 for Ta, 1.22 ev and 0.45 for Mo, 1.37 ev and 10.0 for C, 1.41 ev and 3.55 for W, 1.98 ev and 266.1 for Re, 1.65 ev and 2.09 for Ni, 1.02 ev and 0.05 for Nb, 1.41 ev and 4.68 for 18-8 stainless steel, 3.62 ev and 10^{17} for Hf, and 3.93 ev and 10^{12} for Zr. The value of A is very large for Zr and Hf, far exceeding the theoretical value of 120. The heat of evaporation of cesium from the surface at optimum coverage was found to be 1.30 ev for Nb, 1.39 ev for Ti, 1.41 ev for Ta, 1.51 ev for Mo, 1.66 ev for C, 1.89 ev for W, 1.80 ev for Ni, 2.03 ev for Re, 2.45 ev for Zr, and 3.60 ev for Hf. (TTT).

6448 THE ELECTRON AND IONIC EMISSION OF ZIRCONIUM CARBIDE, LANTHANUM HEXABORIDE, AND THORIUM OXIDE IN CESIUM VAPOR AT LOW PRESSURE. B. I. Mikhailovskii. Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1504-7(Sept. 1964). (In Russian)

A thin layer (~50 μ) of ZrC, LaB_6, or ThO_2 was deposited on a tungsten cathode. A pure tungsten anode served as a reference standard collector. The emitter thermal emissivities $\epsilon(\lambda = 0.665\ \mu)$ were taken as 1.0, 0.4 and 0.7 for ZrC, ThO_2, and LaB_6, respectively. The homogeneity of the coating was verified microscopically. The cesium vapor pressure P was controlled at 10^{-4} to 10^{-6} mm Hg std by immersing the diode in a thermostat. Anode voltages were selected in order to obtain saturation electron and ion currents. The electron emission density j_e as a function of cathode temperature T was plotted at various values of the cesium vapor pressure P. The electron work function Φ_e was calculated from a plot of $\lg j_e = f(1/T)$ at P = const from the Richardson formula. The value of Φ_c' was calculated for a clean surface at a value of the constant A = 120 amps cm^{-2} deg^{-2}, and Φ_c'' was calculated for a surface with an optimum cesium film covering at A = 3 amps cm^{-2} deg^{-2}. The ionic emission density j_p as a function of cathode temperature T was plotted at various values of P. The values of Φ_c', Φ_c'' and Φ_e (in ev) were 4.6 and 1.1 for W (Φ_e not given); they were 2.1, 1.0, and 3.4 for ZrC; 2.7, 0.8, and 3.2 for LaB_6, and 2.7 1.0, and 3.7 for ThO_2. The values of Φ_c' for W, LaB_6, and ThO_2 were close to the literature values. The values of Φ_c'', which refer to the cesium-covered surface, were about the same for tungsten, which had a large value of Φ_c', as for ZrC, LaB_6, and ThO_2, which had significantly smaller values of Φ_c'. The cesium film was less stable on ZrC, ThO_2, and LaB_6 than on W. The heat of absorption Q (in ev) of the Cs film was 1.6 for W, 0.8 for ZrC, 0.9 for LaB_6, and 1.1 for ThO_2. (TTT)

6449 THE SURFACE IONIZATION OF CESIUM ON DIFFUSION OF ITS VAPOR THROUGH POROUS MEMBRANES OF MOLYBDENUM, TUNGSTEN, NICKEL AND RHENIUM. S. Ya. Lebedev and Yu. Ya. Stavisskii. Izv. Akad. Nauk SSSR, Ser. Fiz., 28: 1527-9(Sept. 1964). (In Russian)

On increasing the temperature of a membrane and approaching the ion saturation temperature, cesium atoms are driven from the surface. The attainment of a saturation current indicates that ionization is taking place on a pure surface, for which the ionization coefficient is about 100%. Cesium vapors were passed through a membrane having a porosity of ~30% with a pore size of ~1 micron. The Cs vapor was ionized on the incandescent surface, and the positively charged cesium ions were collected by a Faraday cage held at a low temperature (13°C) in order to condense out the cesium. The surface temperature was measured with a platinum rhodium-platinum thermocouple. The ion current density as a function of surface temperature T was obtained at various Cs vapor velocities. A plot of the ion current j in mA/cm^2 versus 1/T gave straight lines for Mo, W, Ni, and Re at ion currents of 0.1 to 20 mA/cm^2. The energies of adsorption of Cs atoms at low surface coverage with Cs atoms were found to be 2.65 ev for Mo, 2.92 ev for W, 3.04 ev for Ni, and 3.22 ev for Re. (TTT).

6450 ACCURATE COMPUTATION OF VIBRONIC ENERGIES AND OF SOME EXPECTATION VALUES FOR H_2, D_2, AND T_2. W. Kołos and L. Wolniewicz (Univ. of Chicago). J. Chem. Phys., 41: 3674-8(Dec. 15, 1964).

The complete four-particle nonrelativistic Hamiltonian and 147-term wavefunctions were used to compute the energies and the expectation values of several other operators for vibronic ground states and for the first vibrationally ex-

cited states of H_2, D_2, and T_2. For H_2 and D_2 the computed dissociation energies, with relativistic corrections, are by 0.6 and 1.3 cm^{-1}, respectively, larger than the experimental values. (auth)

6451 SPIN DENSITIES IN ALKALI-METAL–AMMONIA SOLUTIONS. D. E. O'Reilly (Argonne National Lab., Ill.). J. Chem. Phys., 41: 3736-42(Dec. 15, 1964).

Wavefunctions for the alkali metal monomers of Li, Na, Rb, and Cs in liquid ammonia were calculated using a multipole expansion potential. The wavefunctions were made orthogonal to molecular orbital wavefunctions for the ammonia molecules surrounding the metal ion and spin densities at the metal, nitrogen, and hydrogen nuclei were calculated. A model is proposed for the cavity species which is exactly soluble within the same approximation. Spin densities were evaluated at nitrogen and hydrogen nuclei following orthogonalization to wavefunctions of ammonia molecules on the periphery of the cavity. Orthogonalization produced a large enhancement of spin density at nitrogen and a corresponding decrease in spin density occurred at hydrogen due to a node in the wavefunction produced by orthogonalization. The calculated spin density at the metal nucleus of the monomer and at nitrogen of the cavity species are in good agreement with experimental values. An explanation for the negative spin density at the protons is proposed. (auth)

6452 NUCLEAR MAGNETIC-DIPOLE COUPLING IN SOLID BF_3. P. A. Casabella (Rensselaer Polytechnic Inst., Troy, N. Y.). J. Chem. Phys., 41: 3793-8(Dec. 15, 1964).

The nuclear magnetic resonances of ^{11}B and ^{19}F were studied in solid polycrystalline BF_3 at 77°K. From a study of the ^{11}B resonance, the ^{11}B nuclear quadrupole coupling constant was found to be 3.045 ± 0.060 Mc/sec. The ^{19}F resonance possessed an unusual asymmetric structure that is explainable in terms of a magnetic-dipole interaction between a ^{19}F nucleus and its nearest-neighbor ^{11}B nucleus. An analysis of this interaction revealed that the observed asymmetry of the ^{19}F resonance indicates that the ^{11}B quadrupole coupling constant is positive. Furthermore, the width of the ^{19}F resonance leads to a value of 1.29 Å for the distance between nearest-neighbor boron and fluorine atoms in the solid in excellent agreement with the known values for BF_3 gas. (auth)

6453 MEASUREMENTS OF THERMAL DISSOCIATION OF HYDROGEN, USING FAST PROTONS. Grant J. Lockwood, Herbert F. Helbig, and Edgar Everhart (Univ. of Connecticut, Storrs). J. Chem. Phys., 41: 3820-4(Dec. 15, 1964).

Experiments involving study of the angular scattering of kiloelectron-volt protons from atomic and molecular hydrogen targets were used to measure directly the fraction of hydrogen gas dissociated in equilibrium with hot tungsten. The state of the hydrogen gas in a tungsten furnace was determined by analyzing the scattered incident particles that result from single collisions between the incoming protons and the hydrogen gas in the furnace. In particular, the number of H^- ions among the scattered particles is a measure of the molecular hydrogen density, since H^- ions cannot be created in single collisions between protons and hydrogen atoms. Under the present experimental conditions it was possible to achieve a fraction dissociation of over 87.5% at a furnace temperature of 2380°K and still higher fractions at higher temperatures. These measurements were made at hydrogen pressures of the order of 10^{-2} torr. The practical conditions under which an atmosphere of highly dissociated hydrogen can be created are described and it is pointed out how the dissociation fraction and also the density of the hydrogen can be directly measured in the otherwise inaccessible interior of the gas. These measurements using a proton beam probe do not require that the pressure or temperature of the hydrogen be known and, in fact, do not require thermal equilibrium conditions. (auth)

6454 NONADIABATIC ELASTIC SCATTERING. II. THE SCATTERING PROCESS. Walter R. Thorson (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys., 41: 3881-4(Dec. 15, 1964).

Previous studies on nonadiabatic elastic scattering of high-energy atomic beams have shown that the potentials that produce such scattering exhibit downward shifts (Coriolis shifts) due to high angular velocities during collisions. The elastic-scattering cross sections produced by such potentials were studied, and it was found that the scattering tends to mask the presence of Coriolis shifts, so that the apparent potential that could be deduced from measurements of such scattering differs from the adiabatic potential by only small fractions of the Coriolis shifts. The 9-ev discrepancy between the potential for He_2 at 0.5 Å, calculated in the adiabatic approximation, and the potential deduced from beam experiments cannot be accounted for in terms of Coriolis shifts. (auth)

6455 SHIFT OF THE LASER EMISSION OF EUROPIUM BENZOYLACETONATE BY INORGANIC IONS. H. Samelson, V. A. Brophy, C. Brecher, and A. Lempicki (General Telephone and Electronics Labs., Inc., Bayside, N.Y.). J. Chem. Phys., 41: 3998-4000(Dec. 15, 1964).

The influence of inorganic ions on the spectroscopy of europium benzoylacetonate was investigated, and the chemical shifting, by this effect, of the laser emission is reported. Different spectra were obtained when various inorganic salts were added to alcohol solutions of the tetrakischelate. Successive additions of sodium acetate to EuB_4P solution give rise to a new line at 6114 Å. The new emission line indicates the presence of a new chelate species. The line becomes more intense with the addition of more Na^+, while the original EuB_4P emission decreases and can be almost totally suppressed. Furthermore, higher Na^+ concentrations cause precipitation of a new compound having its own characteristic emission spectrum. A spiking pattern characteristic of laser action was obtained in laser experiments on EuB_4P solutions with different sodium acetate concentrations. It was concluded that the salt effect enables for the first time a tuning of laser emission by chemical means. (P.C.H.)

6456 ON THE CALCULATION OF THE ELECTROSTATIC INTERACTION OPERATOR MATRIX ELEMENTS FOR COMPLEX ATOMS. A. Jucys, J. Vizbaraite, R. Karazija, A. Savukynas, and A. Bandzaitis (Kapsukas State Univ., Vilnius, USSR and Inst. of Physics and Mathematics, Academy of Sciences, Lithuanian SSR). Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos, 4: 197-212(1964). (In Russian)

The matrix elements of the electrostatic interaction operator for complex electronic configurations are considered. The Racah operators U^k and $V^{kk'}$ are used. The Racah procedure is used to bring the calculation of the exchange part of matrix elements to the way of the calculation of the direct part of the corresponding expressions. The explicit formulas for two electronic shells are given. In the case of almost closed shells the connection between the matrix elements of supplementary shells is used. In the case of two and three electronic shells the more general formulas are given. The formulas for matrix elements contain the 3nj-coefficients with the number of parameters not exceeding six (n = 2) and the reduced matrix elements of operators U^k and $V^{kk'}$. The calculations are carried out in an easy way when the tables of the 6j-coefficients and of the reduced matrix elements of operator U^k and $V^{kk'}$ are available. (auth)

6457 THE MATRIX ELEMENTS OF THE ELECTROSTATIC INTERACTION OPERATOR FOR ONE ELECTRON OUTSIDE THE HALF-FILLED SHELL OF d-ELECTRONS. A. Karosiene, A. Savukynas, and A. Jucys (Inst. of Physics and Mathematics, Academy of Sciences, Lithuanian SSR and Kapsukas State Univ., Vilnius, USSR). Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos, 4: 213-31(1964). (In Russian)

The expressions for the matrix elements of the electrostatic energy operator for the configuration d^5l in the LS-coupling scheme are given in terms of quantum numbers l and L. An expression for the coefficients of the direct integral F_k is given. The factors f'_k are tabulated. The coefficients of the exchange integral G_{l-2} are expressed by formula. Constituent factors of this expression are

tabulated. The coefficients of the integral G_1 are presented. Between the coefficients of the integrals G_{1-2} and G_{1+2} exists a relation which enables one to compute the expressions for g_{1+2} from those for g_{1-} in an easy way. (auth)

6458 THE MATRIX ELEMENTS OF THE ELECTROSTATIC INTERACTION OPERATOR FOR ONE ELECTRON OUTSIDE THE PARTLY OR ALMOST FILLED SHELL OF d-ELECTRONS. A. Savukynas, A. Karosiene, and A. Jucys (Inst. of Physics and Mathematics, Academy of Sciences, Lithuanian SSR and Kapsukas State Univ., Vilnius, USSR). Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos, 4: 233-47(1964). (In Russian)

The consideration of the matrix elements of the electrostatic interaction operator for the configurations $d^N l$ is continued. The configurations with the partly or almost filled shell of d-electrons (N = 1.9; 2.8; 3.7; 4.6) are considered. The coefficients of the radial integrals are expressed in terms of quantum numbers l and L, L being the total orbital quantum number. The relations between supplementary shells are taken into account. The relation between the expressions of coefficients g_{1+2} and g_{1-2} for the configurations under consideration is valid too. (auth)

6459 QUANTUM FIELD PERTURBATION THEORY IN THE CASE OF TWO STATES IN OPEN SHELLS (FIRST AND SECOND ORDERS IN PERTURBATION THEORY). U. Safronova and V. Tolmachov (Karpov Inst. of Physics and Chemistry, Moscow). Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos, 4: 249-61(1964). (In Russian)

The perturbation theory is investigated immediately with the aid of Gell-Mann and Low adiabatic formula in the first and second orders in the case of two occupied states in the open shells. The results are illustrated in Feynman diagrams with denominators. (auth)

6460 THE $L_1-L_{2,3}M_{4,5}$ COSTER-KRONIG TRANSITIONS. W. N. Asaad (Universität, Munster, Ger.). Nucl. Phys., 63: 337-48(Mar. 1965).

The intermediate coupling theory was applied to the $L_1-L_{2,3}M_{4,5}$ Coster-Kronig transitions, using the transition amplitudes calculation by Callan for all elements from Z = 29 to 50 and for seven additional atomic numbers in the range from Z = 76 to 90. The calculations were made assuming intermediate coupling between the two final vacancies in the atom and LS coupling between the initial vacancy in the atom and the hole in the continuum representing the missing Auger electron. The transitions are seen to exhibit a fine-structure spectrum, with line strengths varying markedly with Z. For elements for which all transitions to all the possible final states of the doubly ionized atom are energetically possible, practically the same sum was obtained for the rates as that calculated by Callan's method. However, for elements for which some transitions become energetically impossible, the intermediate coupling theory causes a reduction of the total sum calculated on the basis of extreme jj coupling up to about 15%. An ambiguity that arises as to the energetically impossible transitions for Z = 41 is also discussed. (auth)

6461 THE ENERGY LOSS OF OXYGEN AND CHLORINE IONS IN SOLIDS. W. Booth and I. S. Grant (Manchester Univ., Eng.). Nucl. Phys., 63: 481-95(Mar. 1965).

The stopping powers of solid foils for oxygen and chlorine ions were measured at energies in the region of 1 Mev/amu. All the results can be reproduced to within 5% by a single empirical relation between the velocity of the moving ion and its effective charge. Equilibrium charge distributions for oxygen ions in carbon and gold, and for chlorine ions in aluminum and gold, are also reported. The root mean square charge is found to differ from the effective charge. (auth)

6462 OBSERVATION OF THE INTERSECTION OF MAGNETIC SUBLEVELS OF THE EXCITED STATES OF CESIUM AND SODIUM. G. V. Markova and M. P. Chaika. Opt. Spectry. (USSR) (English Transl.), 17: 170-3(Sept. 1964). Translated from Optika i Spektroskopiya, 17: 319-26(Sept. 1964).

The polarization of the resonance radiation of sodium at 5890 Å ($3^2P_{3/2}-2^2S_{1/2}$) and cesium at 4555 Å ($7^2P_{3/2}-6^2S_{1/2}$) is investigated in fields of 0 to 40 Oe. Besides the maximum at H = 0 (Hanley effect), additional polarization maxima are observed, which have their origin in the intersection of the Zeeman sublevels in the external magnetic field. (auth)

6463 EIGENVALUES AND QUANTUM TRANSITION PROBABILITIES FOR AN ASYMMETRICAL DOUBLE POTENTIAL WELL. E. A. Pshenichnov and N. D. Sokolov. Opt. Spectry. (USSR) (English Transl.), 17: 183-5(Sept. 1964). Translated from Optika i Spektroskopiya, 17: 343-8(Sept. 1964).

Eigenvalues and quantum transition probabilities were calculated for an asymmetrical double potential well. The effect of deuterium on the spectrum of a hydrogen bond and the probable spectroscopic appearance of an asymmetrical double well are discussed. (auth)

6464 KINETIC THEORY OF DENSE GASES. III. THE GENERALIZED ENSKOG EQUATION. David K. Hoffman and C. F. Curtiss (Univ. of Wisconsin, Madison). Phys. Fluids, 7: 1887-97(Dec. 1964).

The theory of transport phenomena in a gas is considered from a statistical mechanical viewpoint. The formalism is based on the Liouville equation for the time evolution of an ensemble of systems and the Bogoliubov-Born-Green-Kirkwood-Yvon (BBGKY) equations which are integrals of the Liouville equation. The BBGKY hierarchy is truncated by a factorization principle which is a generalization of the molecular chaos assumption. For purely repulsive potentials, the set of equations obtained by truncating at $f^{(3)}$ is shown to give rise to the three-body interaction term obtained by Hollinger and Curtiss and, by a different argument, by Bogoliubov. The two coupled equations obtained by truncating the BBGKY hierarchy at $f^{(2)}$ are considered in detail. An approximation to these equations leads to a Boltzmann equation which is a soft potential generalization of the Enskog dense gas equation for rigid spheres. This Boltzmann equation includes both collisional transfer and three-body collision effects. (auth)

6465 KINETIC MODEL EQUATIONS FOR A GAS MIXTURE. T. F. Morse (Brown Univ., Providence). Phys. Fluids, 7: 2012-13(Dec. 1964).

The parameters of the Gross and Krook kinetic model equations for a binary mixture are derived. It is also shown that the model equations satisfy an H theorem under certain restrictions on the parameters. (D.C.W.)

6466 CALCULATION OF THE $p + H_2 \rightarrow H^- + 2p$ REACTION CROSS SECTION. Marvin H. Mittleman (Univ. of California, Livermore). Phys. Rev., 137: A1-3(Jan. 4, 1965). (UCRL-7955)

A method recently presented for calculation of double-charge transfer cross sections is applied to this reaction. The method neglects correlation between the two transferred particles. The amplitude for two-particle exchange is then obtained as the square of the amplitude for single-particle exchange. The one-particle exchange amplitude is calculated in Born approximation and in a modified Born approximation (modified to correct for nonorthogonality), and the two-particle exchange cross section is obtained from these. Neither calculation should be good at the energies at which the cross section was measured, but the two calculations straddle the measured values. The corrected one appears to give a good agreement at the higher measured energies. (auth)

6467 ROTATIONAL EXCITATION OF MOLECULAR IONS BY ELECTRONS. Douglas H. Sampson (General Electric Co., Valley Forge, Penna.). Phys. Rev., 137: A4-10 (Jan. 4, 1965).

The first-order perturbation theory used by Stabler to compute the cross section for rotational excitation of homonuclear diatomic molecular ions by electrons is shown to be equivalent to an approximation to the method of distorted waves for which quite precise validity criteria can be given and easily applied. It appears to be valid to express the interaction energy by the form $V(r) = V_0(r) + V_2(r)\,P_2(r, s)$; however, use of the long-range forms for $V_0(r)$ and $V_2(r)$ for

all r is not a valid approximation. Moreover, for $r > r_0$, where r_0 is the approximate radius of the molecular charge cloud, $V_2(r)$ should include the r^{-4} induced-dipole or polarization interaction, which, it is shown, likely gives a contribution only a little less significant than that due to the quadrupole interaction treated by Stabler. Depending on the sign and magnitude of the quadrupole moment and the magnitude and degree of asymmetry of the polarizability, and also depending on the size of the uncertain contribution from the region $r < r_0$, the electron-energy loss rate through rotational excitation can be anywhere between ~100% and a negligible percentage of that due to elastic Coulomb collisions with molecular ions. However, if it is $\gtrsim 10\%$, use of the method of distorted waves, or equivalently the perturbation theory with $V_0(r)$ included in H_0 used by Stabler, is shown to be invalid. (auth)

6468 PRODUCTION OF HIGHLY EXCITED NEUTRAL ATOMS FOR INJECTION INTO PLASMA DEVICES. S. T. Butler and R. M. May (Univ. of Sydney). Phys. Rev., 137: A10-16(Jan. 4, 1965).

The production of highly excited states of atomic hydrogen by charge-exchange reactions is considered, discussing first the reaction $H^+ + H(1s) \rightarrow H$ (excited) + H^+; the results for this reaction are used as a basis with which to compare excited-state production in hydrogen atoms by charge exchange in gases other than atomic hydrogen. The results are expressed in terms of the equilibrium ratio i_n/i_c —the ratio of the flux of excited states with principal quantum number n to the (constant) flux of protons incident on the neutralizer. It is found that with atomic hydrogen as neutralizer the ratio i_n/i_c has a maximum of about $0.75/n^3$ at 20 kev. For alkali atoms such a lithium and sodium, the maximum value of i_n/i_c occurs at about 10 kev, being of similar magnitude to, but probably smaller than, the value for atomic hydrogen. In the case of the inert gases helium, neon, and argon, the maximum value of i_n/i_c occurs in the vicinity of 50–70 kev and again is of similar magnitude to, but probably slightly larger than, the maximum value for atomic hydrogen. The inert gases thus offer a number of advantages over alkali gases as neutralizers. They probably yield as large, if not larger, values of i_n/i_c at maximum; the maximum occurs at higher energies, so that the natural decay lengths of the excited atoms are correspondingly longer. (auth)

6469 SELF-CONSISTENT-FIELD DIRAC-SLATER WAVE FUNCTIONS FOR ATOMS AND IONS. I. COMPARISON WITH PREVIOUS CALCULATIONS. D. Liberman, J. T. Waber, and Don T. Cromer (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 137: A27-34(Jan. 4, 1965). (LADC-6278)

Self-consistent-field solutions were obtained of the two first-order linear differential equations that result from the Dirac equation. These solutions for the major and minor components of the (nlj) eigenfunctions were obtained by the relativistic equivalent of the method Herman and Skillman used for atomic structure calculations in which exchange was handled by Slater's $\rho^{1/3}$ method. Detailed comparisons between the energy eigenvalues and electronic energy levels determined from x-ray spectroscopic data were made for Cu^{+1}, Fe, W, and Pt, and particularly for Hg and U. The agreement was very good—better than that obtained in any previous self-consistent-field calculations available. (auth)

6470 MAGNETIC HYPERFINE STRUCTURE OF THE $^3P_1$ AND $^3P_2$ METASTABLE STATES OF $Sn^{115,117,119}$. W. J. Childs and L. S. Goodman (Argonne National Lab., Ill.). Phys. Rev., 137: A35-42(Jan. 4, 1965).

The magnetic hfs of the metastable $^3P_1$ and $^3P_2$ states was studied in the stable odd-A isotopes ^{115}Sn, ^{117}Sn, and ^{119}Sn. The interaction constant $a(^3P_1)$ is found to have the values +507.445(4), +552.608(4), and +578.296(4) Mc/sec in the isotopes ^{115}Sn, ^{117}Sn, and ^{119}Sn, respectively. It is also found that $a(^3P_2)$ has the values −1113.770(4), −1212.956(3), and −1269.419(3) Mc/sec for the same isotopes. The results are compared with the theory. Values of the hyperfine anomalies are also given. (auth)

6471 KINETIC SECONDARY ELECTRON EJECTION FROM MOLYBDENUM BY CESIUM IONS. Samuel H. Bosch (Electro-Optical Systems, Inc., Pasadena, Calif.). Phys. Rev., 137: A255-8(Jan. 4, 1965).

Secondary electron emission yields were measured for Cs ions on clean Mo as a function of ion kinetic energy at 0 and 40°. For the two incidence angles, the energy threshold was the same, approximately 2 kev. From this threshold there was a quadratic rise in the values of γ_i (the number of secondary electrons per incident ion) with an increase in energy up to 5.5 kev. From then on, the values of γ_i were a linear function of ion energy up to 15 kev, where they were 0.55 and 0.69 for the 0 and 40° angles of incidence, respectively. The values of γ_i for the 40° angle of incidence were always greater than those for normal incidence by the factor of sec 40°. The targets were atomically cleaned by flashing at 2000°C. All measurements were taken with ambient pressures less than 5×10^{-8} torr. (auth)

6472 EFFECT OF ELECTRON-ELECTRON INTERACTION ON THE KINETIC-ENERGY DISTRIBUTION OF ELECTRONS EJECTED FROM SOLIDS BY SLOW IONS. H. D. Hogstrum and Y. Takeishi (Bell Telephone Labs., Murray Hill, N. J.). Phys., Rev., 137: A304-10(Jan. 4, 1965).

A method is presented for detecting the effect of the interaction between fast Auger electrons inside a solid (up to about 12 ev above the vacuum level) and band electrons of the solid. The fast electrons are produced by Auger neutralization of noble gas ions at the solid surface, and their interaction with band electrons is observed in the change with incident ion energy of the kinetic-energy distribution of ejected electrons measured outside the solid. As incident ion energy is increased, the number of faster Auger electrons increases, which, in turn, increases the number of secondary electrons produced by them inside the solid. Data on Ge and Ni are presented here. Numerical estimates, based on the observed changes in kinetic-energy distribution and the assumption of a linear probability of secondary formation having a threshold at 4.5 ev, indicate that the secondary component for 4-ev ions amounts to about 10% of the total electron distribution for He^+ on Ge(111), 8% for Ne^+ on Ge(111), 4% for He^+ on Ni(111), and 2% for Ne^+ on Ni(111). (auth)

6473 CHARGE OF LITHIUM IONS IN A MERCURY BEAM. Klaus Bethge and Godehard Guenther (Universität, Heidelberg). Z. Angew. Phys., 17: 548-53(1964). (In German)

In the energy region from 25 to 70 kev the charge of positive lithium ions in a supersonic mercury beam was investigated. The yield of negatively charged ions was especially measured. It was found that the maximum yields occur at energies between 60 and 70 kev and result in a ratio $Li^-/Li^+ = 5 \times 10^{-5}$. The yield of neutral particles amounted to $Li^0/Li^+ = 6 \times 10^{-2}$. On the basis of these results these methods could not be of importance for production of negative lithium ions for acceleration in a tandem Van de Graff generator. (tr-auth)

6474 INVESTIGATION OF FAST ADIABATIC COLLISIONS WITH FISSION PRODUCTS. P. Armbruster, E. Roeckl, H. J. Specht, and A. Vollmer (Technische Hochschule, Munich). Z. Naturforsch., 19a: 1301-4 (Nov. 1964). (In German)

Fission products were stopped in targets of various atomic numbers. The ionization of inner electron shells appearing from this was measured with the help of characteristic x radiation as a function of the energy and mass of the fission products and the atomic number of the target atoms. In addition, the dependence of the energy of the L radiation of the fission products on the atomic number of the target atoms was found. (tr-auth)

6475 ANGULAR REGULARITIES IN SPUTTERING AND SECONDARY ELECTRON EMISSION AT LARGE ANGLES OF ION INCIDENCE ON TARGETS. E. S. Mashkova and V. A. Molchanov. Zh. Tekhn. Fiz., 34: 2081-2(Nov. 1964). (In Russian)

Measurements of the angular dependence of ion-

electron emission were carried out for ions incident from 60 to 86°, using Cu, W, Ni, and Mo targets. Measurement errors were ± 7%. The coefficients of sputtering and emission were measured at Ar ion energy of 30 kev for Ni and W. For Cu and Mo, the emission coefficient was determined at 30 kev and the sputtering coefficient at 27.5 kev. Curves of the results are presented. An explanation of the observed maxima in the sputtering coefficient curves and the lack of maxima in the emission curves is given. (M.J.T.)

6476 THE APPLICATION OF SCREENED HYDROGENIC WAVE FUNCTIONS TO TWO-ELECTRON EXCITATION STATES IN HELIUM. Frederic R. Crownfield, Jr. (Coll. of William and Mary, Williamsburg, Va.) and Peter Havas. 7p. (CONF-452-60)

From American Physical Society, Washington, D. C., Apr. 1964.

Screened hydrogenic wave functions were used to calculate the locations of discrete two-electron excitation levels, as well as cross sections for simultaneous photo-excitation of two electrons in helium-like atoms. The method of calculation is described, and the relation of the theoretical and recent experimental results is discussed. (auth)

6477 ELECTRODE EROSION BY CESIUM ION SPUTTERING. H. L. Daley, M. P. Ernstene, S. L. Eilenberg, and J. Perel (Electro-Optical Systems, Inc., Pasadena, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-687, 25p, $1.00. (CONF-640801-6)

From 4th Electric Propulsion Conference, Philadelphia.

Experimental and analytical investigations were made to examine the erosion by sputtering of possible electrode materials. The investigations include the measurement of sputtering yields under controlled experimental conditions, erosion data from extended duration engine tests, and erosion rate calculations. Sputtering yield measurements of various materials are presented for cesium ion bombardment at energies up to 15 kev and at various ion angles of incidence. Erosion data from extended duration engine tests are also presented for several materials. In these extended duration tests, copper was used as a control material to permit comparison of erosion data. Erosion rates were calculated from the sputtering yield data, ionizer comparison data, and $Cs^+ - Cs$ charge exchange cross sections. The results are indicative of the trade-off between engine lifetime and current density. (auth)

6478 TWO-DIMENSIONAL COMPUTER EXPERIMENTS ON ION-BEAM NEUTRALIZATION. R. P. Wadhwa (Litton Industries, San Carlos, Calif.), D. F. Brauch, and O. Buneman. New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-698, 14p, $1.00. (CONF-640801-13)

From 4th Electric Propulsion Conference, Philadelphia.

A method for analyzing space-charge neutralization in a two-dimensional ion engine configuration is outlined, together with the treatment of the creation of a moving plasma by this technique. The two-dimensional computer model is considered in some detail. (D.C.W.)

6479 THE MASS SPECTROMETRY OF IONS IN GLOW DISCHARGES. P. H. Dawson, P. F. Knewstubb, and A. W. Tickner (National Research Council, Ottawa). 4p. (CONF-649-7)

From 12th Annual Conference on Mass Spectrometry and Applied Topics, Montreal, June 1964.

The technique of mass spectrometry was used to study directly the ions in chemical reactions. The d-c glow discharge in particular was chosen for study as one that offered a variety of conditions of excitation. The region of negative glow was studied with the greatest interest. The types of information that can be obtained are illustrated by considering briefly some of the systems that have been studied. In general, the results take the form of plots of ion current sampled by the probe, which is proportional to the ion concentration in front of the probe versus distance from the cathode. Relative cross sections of gases were calculated relative to that of argon and were compared with those of others. Good agreement was found for the rare gases and for O_2 but not for N_2 and CO. (P.C.H.)

Cosmic Radiation

Refer also to abstract 6006.

6480 ANGULAR DISTRIBUTION ASYMMETRY OF SHOWER PARTICLES. L. A. San'ko and P. A. Usik. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 82-93 (1963). (In Russian)

The angular distribution asymmetry of 10^{11} ev cosmic shower particles was studied. The mean meson energy in the π cloud and its relation to the anisotropic parameter and γ_c magnitude were estimated. The angular distribution asymmetry in the center-of-mass system was studied assuming excitation of one of the interacting nucleons. The frequency of asymmetric events was calculated on the basis of binomial distribution, and the results were compared with the frequency of 9-Bev proton and 7.5-Bev π meson interactions in emulsion. (R.V.J.)

6481 MEASUREMENTS OF ENERGETIC ELECTRONS IN THE VICINITY OF THE SUNWARD MAGNETOSPHERIC BOUNDARY WITH EXPLORER 14. L. A. Frank and J. A. Van Allen (State Univ. of Iowa, Iowa City). J. Geophys. Res., 69: 4923-32(Dec. 1, 1964).

Observations with the satellite Explorer 14 to radial distances of 16 R_E (earth radii) on the generally sunward side of the earth establish the mean geocentric radial distance of the magnetospheric boundary near the sun-earth line as ~11 R_E during May–August 1963, a period of relatively low geomagnetic activity in the epoch six years after sunspot maximum. Isolated 'spikes' of electrons having $40 < E_e < 200$ kev and omnidirectional intensities lying between the detector's threshold of $\sim 5 \times 10^3$ and $\sim 10^5$ cm^{-2} sec^{-1} are often but not always observed in a transition region of radial thickness 2 to 3 R_E beyond the magnetospheric boundary. These electrons are interpreted as being in the high energy tail of the spectrum of the quasi-thermalized plasma E_e ~1 to 10 kev observed in this region by Explorer 12. The incidence of the spikes and the complexity and intensity of their radial profiles increase with increasing K_p. The geocentric radial distances of both the magnetospheric boundary and the outer boundary of the transition region increase with increasing angle from the sun-earth line toward local evening, and the latter boundary apparently lies beyond 16 R_E on the local sunset meridian. Electrons of energies exceeding 1.6 Mev are observed in localized 'hot spots' in the transition region near local morning, implying further heating of electrons in the solar plasma as it flows around the magnetosphere. It is suggested that the temporal variations of intensity of electrons E_e ~1.5 Mev, for example, in the outer radiation zone can be attributed in large part to inward, radial diffusion of electrons E_e ~300 kev from the magnetospheric boundary when relatively strong electron heating occurs in the adjacent transition-region plasma during geomagnetically disturbed periods, and that a diffusion mechanism operates continuously within the earth's magnetosphere, thus accounting for the sporadic, large increases of intensity of energetic electrons E_e ~1.5 Mev in the outer radiation zone following periods of geomagnetic activity as being due to a variable source in the transition region. (auth)

6482 ROCKET OBSERVATIONS OF SLOW HEAVY PRIMARY NUCLEI AT KRONOGÅRD, SWEDEN. H. Yagoda (Air Force Cambridge Research Labs., Mass.), K. Fukui, E. Holeman, K. Kristiansson, and B. Lindkvist. Nuovo Cimento (10), 34: 854-9(Nov. 16, 1964).

Small emulsion blocks recovered from a series of Nike-Cajun rockets launched from Kronogård, Sweden, exhibit the tracks of slow heavy primary nuclei which stop by ionization in the detectors. The charge distribution of these particles, estimated from track width measurements, is consistent with a galactic origin. The kinetic energy of the particles estimated from their range lies between 60 and 570 Mev per nucleon. This preliminary experiment suggests that important information on the charge and energy spectra can be secured by exposing large areas of emulsion in geophysical sounding rockets. (auth)

6483 THE MUON SPECTRUM AT 3000 m ALTITUDE. O. C. Allkofer and J. Truemper (Universitat, Kiel). Z. Naturforsch., 19a: 1304-9(Nov. 1964). (In German)

At an altitude of 3000 m the total spectrum of cosmic-ray particles was measured with the help of a magnetic pulse spectrograph and the meson (μ) spectrum was derived from that. Comparative measurements were carried out at sea level with the same equipment. In addition, from the spectra of positive and negative particles, the course of the charge ratio was determined. By inclination of the spectrograph from the zenith angle to 37.5 in an east–west direction, the spectral intensity decrease was investigated. The measuring range of the spectrograph varied from 2×10^8 to 2×10^{10} ev/c. (tr-auth)

Direct Energy Conversion

6484 (APL-TDR-64-120) HIGH-VOLTAGE THERMIONIC CONVERTERS. D. L. Dresser (General Motors Corp. Allison Div., Indianapolis). Sept. 1964. Contract AF33(615)-1533. 110p. (AD-607864) $4.00 (OTS).

Several emitter materials and two emitter geometries were evaluated in a flexible laboratory thermionic converter design. Experimental results are reported from six converters that were tested for a total of 1070 hr. (auth)

6485 (CEA-R-2519) LES EFFETS DES TACHES (OU GRAINS) ET LE TRAVAIL DE SORTIE MOYEN D'UN EMETTEUR POLYCRISTALLIN. (The Effects of Spots (Or Grains) and the Mean Work Function of a Polycrystalline Emitter). Bernard Devin and Nguyen Xuan Phuc (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). July 1964. 52p. Dep.(mn).

The direct conversion of thermal energy at high temperature to electrical energy using plasma diodes is studied. Research concerns the adaptation of these diodes to nuclear reactors with a view especially to providing power for operating the instruments of space vehicles. In parallel with the semi-industrial realizations and tests, part of the activity is directed towards fundamental research into physical phenomena connected with thermionic emission with a view to improving performances. (auth)

6486 (GEST-2037) INVESTIGATION OF THERMIONIC CONVERTER OPERATING WITH A HIGH-TEMPERATURE COLLECTOR. Second Quarterly Technical Report, May 15, 1964–August 15, 1964. (General Electric Co. [Vallecitos Atomic Lab.], Pleasanton, Calif.). Contract AF33(615)-1545. 46p. (AD-605539). $1.00 (OTS).

Work during the period on measurement of electrode work functions in vacuo, thermal calibration of the emitter in vacuo, and thermal calibration of the emitter in Cs vapors for the uncooled collector converter is reported. Measurement of current-voltage characteristics and converter efficiencies for several electrode temperatures and spacings is also reported along with Cs vapor measurements. Progress is reported in assembly of the cooled collector converter. Calibration of apparatus for measuring electrode temperature and light absorption by Cs vapor is described. (J.R.D.)

6487 (LA-3143-MS) IONIZATION PHENOMENA IN A CESIUM THERMIONIC CONVERTER PLASMA. Daniel Wilkins (Los Alamos Scientific Lab., N. Mex.). Aug. 28, 1964. Contract W-7405-eng-36. 37p. Dep.; $2.00(cy), 1(mn) OTS.

Molecular and atomic ion formation in cesium plasmas of thermionic interest are compared. It is found that for emitter temperatures greater than 1700°K, the atomic ions are the dominant species. Below 1700°K, there appears to be a narrow range of electron temperatures in which it is possible for the number of molecular ions to be comparable to the atomic ion number. There is also a narrow range of electron temperature in which the atomic ion density may sharply increase by as many as two orders of magnitude. This sharp increase may give rise to the ignited mode of operation noticed in many converters when sweeping from the open circuit condition to the short circuit condition. (auth)

6488 (PWA-2369) LIQUID-METAL-HEATED SPACE-RADIATOR-MOUNTED THERMIONIC GENERATOR. F. C. Harter (Pratt and Whitney Aircraft Div., United Aircraft Corp., Hartford, Conn.). Oct. 1964. Contract AF33-(657)-11320. 153p. (AD-608061; APL-TDR-64-121) $5.00 (OTS).

Thermionic generators are evaluated in a configuration appropriate for liquid metal heating at temperatures up to 1500°C. The thermionic generator evaluated was cylindrical and consisted of a nickel collector surrounding a trilayer emitter structure. The trilayer structure consisted of a tantalum–tungsten alloy tube, which could contain the liquid metal, surrounded by a concentric insulating beryllium–oxide tube and a tungsten–rhenium alloy emitter tube. The generator met or exceeded the performance goals of the program. At an emitter temperature of 1500°C, the power density measured was 50 per cent greater than the design objective of 4 W/cm^2, and the measured efficiency matched the goal of 10 per cent. The power density of 1.07 W/cm^2 at 1195°C exceeded the performance goal of 1 W/cm^2 at 1200°C. The generators were tested under conditions which simulated liquid metal heating and radiation cooling of the generators. Strong electronic and thermal interrelations were observed during these tests. Significant discontinuities were found in the current-voltage relationship and a thermal quasi-instability was observed resulting from variations in the electronic heating of the collector. In addition, electronic cooling of the emitter produced a significant axial temperature variation which depended on the method of applying the load. This axial temperature variation produced axial variations in the emitter work function. The average work functions of the emitter and collector also varied with the generator voltage in the regions of high generator current (ion-rich regions). The trilayer emitter assembly maintained its electrical insulating properties, but the thermal resistivity varied from 2.5 to 10°C/W$_{thermal}$ / cm^2. To attain adequate heat flux through the trilayer assembly, high central tube and heater temperatures were required. These led to test system difficulties which subjected the generator to major thermal cycling from operating to room temperature. Other thermal cycling (from open circuit to power producing conditions) and the major thermal cycling induced fatigue in the ceramic seals which limited the life of the generators. (auth)

6489 (SC-RR-64-979) THE HYPERSONIC PLASMA CONVERTER. PART II. K. J. Touryan (Sandia Lab., Albuquerque, N. Mex.). Nov. 1964. Contract AT(29-1)-789. 46p. Dep.; $1.00(cy), 1(mn) OTS.

In a study of the hypersonic plasma generator known as ASP (Aerodynamic Supply of Power), experimental analyses were extended to investigate in detail the various parameters that govern the operation of the generator. A final feasibility study was made, and possible modifications to the theory are outlined. Test runs in an arc jet with air as the working fluid at 12,000 BTU/lb generated 8 amp/in^2 short circuit currents and 2.3 volts open circuit voltage. Under favorable conditions, full-size re-entry vehicles in the altitude range of 200,000 to 80,000 feet are expected to yield several kilowatts of power. (auth)

6490 PROPERTIES OF A CESIUM PLASMA THERMOELECTRIC CONVERTER WITH EXTERNAL EMITTER. Eugène Dieulesaint and Jean-Louis Desplat (Compagnie Francaise Thomson-Houston, Bagneux, France). Compt. Rend., 259: 2380-3(Oct. 12, 1964). (In French)

The functioning of cesium plasma converters with an external emitter was studied systematically. The constitution of this emitter makes possible low temperature functioning (1300°C). According to the values of the parameters, a stable regime yielding electric energy in its direct form or an instable regime characterized by high-frequency oscillations was obtained. (tr-auth)

6491 A GAS-FIRED EXPERIMENTAL MAGNETOHYDRODYNAMIC POWER GENERATOR MARK I. [PART] II. Fusawo Mori, Kozo Fushimi, Takashi Kutsuwada, and Shigeru Ikeda (Electrotechnical Lab., Tokyo). Denki Shikensho Iho, 28: 243-52(1964).

Construction features of an experimental MHD generator

and results of its operation are described. The generator derives its energy from combustion of propane, methyl alcohol, in which KOH is dissolved, and oxygen; and it has a generator channel of constant area type, $2 \times 6 \times 19$ cm in size. The duct is constructed of magnesia walls and graphite electrodes, and stands for a period of 3 to 5 minutes under the running condition. A maximum output of about 720 W is obtained with the generator when the mass flow is about 110 g/sec. (auth)

6492 OPTICAL MEASUREMENT OF FLAME TEMPERATURE IN MAGNETOHYDRODYNAMIC GENERATOR. Kozo Fushimi and Masoomi Kimura. Denki Shikensho Iho, 28: 253-62(1964). (In Japanese)

An application of a modified sodium-resonance line reversal technique to the measurement of flame temperatures in a magnetohydrodynamic generator, the so-called two-path method, was investigated. The flame is of combustion of propane + O_2, with seeding of solution of KOH and NaOH in methyl alcohol. The flame temperatures are calculated from variation of radiation intensity produced by intermittently transmitting light from a tungsten lamp through the combustion flame. The degree of variation of radiation intensity is a function of absorptivity and emissivity of the flame and the radiation intensity of the tungsten light source. From the known radiation theory the variations of radiation intensity are sufficient to calculate actual flame temperature. This apparatus consists of a tungsten light source, a lens, a light chopper, an interference filter, and a photomultiplier. In this method the radiation intensity of the tungsten lamp, that of the tungsten lamp through the flame, and that of the flame only are measured separately. The experimental results indicated that the flame temperatures are 2830 ± 50°K, 2870°K at maximum, and that the flame effective emissivity at Na line 0.3 to 0.5 dependent on the flame temperatures and the optical depth, i.e., Na-atom density multiplied by the flame length along the optical path. (auth)

6493 ELEVATION OF ELECTRON DENSITY BY THERMAL EMISSION FROM SUSPENDED DUST PARTICLE. Kozo Fushimi, Takuya Honma, and Masahiko Tamura. Denki Shikensho Iho, 28: 273-80(1964). (In Japanese)

The possibility is estimated in magnetohydrodynamic power generation to give a required conductivity to the working fluid using the thermoelectric emission from suspended metal powder. A general equation is formulated to give the relation between the powder density and the resulting electron density, and its numerical examples for the case of LaB_6 powder of 1 μ diameter are given, showing that an electron density of $1.5 \times 10^{13}/cm^3$ is attained with powder density $10^{11}/cm^3$ at 2300°K. An experimental scheme is shown. (auth)

6494 A DESIGN OF 1000 kw MHD POWER GENERATION DUCT. Kozo Fushimi, Takuya Honma, and Shigeru Ikeda. Denki Shikensho Iho, 28: 284-7(1964). (In Japanese)

An approximate calculation is given for a duct design of 1000 kW magnetohydrodynamic power generator with the condition of a constant gas speed, using the combustion gas of kerosene and oxygen seeded with potassium in the magnetic field intensity of 3.5 wb/m^2. It is shown that the output of 1375 kW is attainable; provided that the duct scale is 2.3×10^{-2} m^2 at maximum cross section and 1.2m in length, and the temperature and the speed of the gas at the inlet are 3000°K and 1000m/sec. respectively. It is assumed that the heat and friction losses are negligible. (auth)

6495 PREPARATION, FABRICATION AND PROPERTIES OF BORIDES (EMITTING ELECTRODE MATERIALS FOR MHD POWER GENERATION). Hiroshi Nakatani, Hiroshi Koyama, and Masayuki Hirabayashi. Denki Shikensho Iho, 28: 288-99(1964). (In Japanese)

An investigation was carried out into the applicability of borides of transition metals, high in melting point, hardness, and stability, and low in electric resistivity, to the emitting electrodes of magnetohydrodynamic generator to withstand temperatures higher than 2500°K. The preparation, fabrication, and properties of borides electrode materials are given. (auth)

6496 ON THE MEASUREMENT OF FLAME TEMPERATURES OF MAGNETOHYDRODYNAMIC GENERATOR IN THE INFRARED REGION. Masaomi Kimura. Denki Shikensho Iho, 28: 300-15(1964). (In Japanese)

Chemical flames emit most of their radiant energy in the infrared region of the spectrum, and the use of this radiation for flame temperature measurements was extensively investigated. Although some hot gases emit visible and ultraviolet radiation in addition to infrared, it is desirable and often essential to use infrared radiation for gas temperature measurements. The radiative lifetimes associated with infrared radiation are usually long, e.g., 0.001 to 0.1 sec., compared with the time required for equilibrium to be reached between the radiative and translational degrees of freedom (10^{-8} to 10^{-6} sec.). The temperature sought is what corresponds to the translational kinetic energy of gas. Hence the gas temperature can be determined from radiation measurements only when the radiative degree of freedom involved is in equilibrium with the translational kinetic energy of gas. The above-mentioned consideration favors the use of infrared radiation for measurements of gas and plasma temperatures. The measured values of transmission, emissivity and absorptivity are listed together and compared with their theoretical values calculated according to recent investigations by several researchers, and the region in which the Beer's law is valid is discussed. (auth)

6497 EFFECT OF CESIUM FLUORIDE ON A CESIUM VAPOR DIODE. C. H. Skeen (Atomics International, Canoga Park, Calif.). J. Appl. Phys., 36: 84-8(Jan. 1965).

A cesium vapor diode was operated both before and after cesium fluoride was introduced into the interelectrode space. The electrodes were plane parallel, had a cross-sectional area of 2 cm^2, and were made of molybdenum having a polycrystalline surface. The interelectrode spacing was varied from 0.01 to 10 mm. The cesium fluoride vapor additive caused an increase in the optimized output power density. For a given emitter temperature this enhancement increased with spacing until the spacing reached about 0.89 mm, after which it became uniform. The enhancement decreased with an increase in emitter temperature. The increase averaged about 20% for a combination of these cases. When all parameters were held constant except the cesium fluoride reservoir temperature, an increase in the additive vapor pressure caused the enhancement to decrease. The optimum collector temperatures decreased up to 2% after the cesium fluoride addition. The optimum cesium vapor pressures were decreased by about 15°K after the CsF addition. (auth)

6498 AN ANALYSIS OF DIRECT ENERGY CONVERTERS BY THE METHODS OF IRREVERSIBLE THERMODYNAMICS. Lawrence Baylor Robinson and Robert Carroll Beaty (Univ. of California, Los Angeles). J. Appl. Phys., 36: 142-53(Jan. 1965).

Methods of thermodynamics of irreversible processes are presented within the framework of the Burgers-Pipkin solution of the Boltzmann transport equation. The thermionic energy converter is treated as a thermocouple and analyzed by the nonequilibrium thermodynamic methods which are developed. Following a general treatment, the cesium diode is treated as a specific example. Detailed calculations are made of the thermal conductivity and the electric conductivity, as well as the ratio. In making the calculations, contributions from the electrons, positive ions, and neutral particles, are considered as well as interactions among the various types of particles. Binary interactions between the neutral particles, collective (Coulomb) interactions among charged particles, and (quantum-mechanical) collisions between electrons and neutral particles are taken into account. Each type of interaction has its appropriate effect on the thermal and electric conductivities. A brief discussion of the results and implications of the analysis is given, along with a reiteration of the assumptions and the limitations of the calculation. (auth)

6499 THERMIONIC GENERATORS ACT AS NUCLEAR FUEL WHILE PRODUCING POWER. J. Myatt (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Mod. Power and Eng., 58: 46-8(Nov. 1964).

The possible use of cesium diode power generators to capture the waste heat in thermal and nuclear generating stations is described. In-pile diode concept incorporates reactor fuel in emitter structure. Out-of-pile concept uses heat from the reactor coolant to operate the thermionic generator. Core surface diodes are mounted directly on the reactor core. Efficiencies of 40–50 per cent are forecast. With operation at up to 700°C there appears to be no reason why the diode and the steam cycle should not operate in series. (F.S.A.)

6500 ELECTRIC POWER GENERATION. Newell D. Sanders, James F. Morris, Lester D. Nichols, Andrew E. Potter, Jr., Harvey J. Schwartz, and Warner L. Stewart (Lewis Research Center, Cleveland). p.65-89 of "NASA SP-5015."

New developments in electric power generation that have their origins in the space-associated programs are discussed. Possible earth-bound applications of these developments are emphasized. Discussions are included on batteries, solar cells, thermoelectric converters, fuel cells, turbine power systems, magnetohydrodynamic converters, and thermionic converters. (J.R.D.)

6501 ELECTRON EMISSION IN MHD GENERATORS. D. Halász, Ch. Szendy, and Ch. P. Kovács (Inst. for Energy Research, Budapest). 7p. (CONF-640701-56)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The emission of electrons in an MHD generator using a seeded gas was analyzed, with particular emphasis on the temperature requirements. (D.C.W.)

6502 ELECTRICAL CONDUCTIVITY AND BREAKDOWN IN CAESIUM VAPOUR. A. Sands (International Research and Development Co. Ltd., Newcastle-upon-Tyne, Eng.) and D. Balfour. 7p. (CONF-64071-57)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

Electrical breakdown in cesium vapor was investigated using both a-c and d-c discharges. The transition from low to high conductivity modes of discharge particularly was studied. It was found that in cesium vapor at 750°K and at a pressure of between 10^{-2} and 1 torr, the discharge current increases rapidly whenever the electric field in the gas exceeds ~ 10 v/cm. The conditions for maintaining this arc mode of discharge were determined. (D.C.W.)

6503 EXPERIMENTAL STUDIES IN OPEN-CYCLE MHD GENERATION. G. J. Womack, I. A. McGrath, and M. W. Thring (Univ. of Sheffield, Eng.). 14p. (CONF-640701-61)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

For an MHD generator incorporating hot carbon electrodes, the electrical conductivity, effective collision frequencies, and collision cross sections of potassium-seeded combustion products were measured at gas temperatures and seed concentrations in the ranges 2200 to 2500°K and 0.4 to 1.6% by weight potassium. The measured conductivities were found to agree well with the theoretically calculated values. For an MHD generator incorporating water-cooled copper electrodes, the electrical conductivity was lower than the theoretical electronic conductivity, but nevertheless it appeared to correspond to the electronic and not ionic mode of conduction. Low frequency voltage noise was observed and was tentatively attributed to low frequency combustion instabilities. The electron mobility, cyclotron frequency, and mean collision time were measured and found to agree well with theoretically obtained values. (auth)

6504 ELECTRICAL POTENTIAL VARIATION LAYERS NEAR ELECTRODES. G. A. Liubimov (Moscow State Univ.). 4p. (CONF-640701-62)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The volt-ampere characteristic for gas flow between electrodes was calculated, including the effect of layers of potential change at the electrodes. The results were compared with other calculations and experimental results. (D.C.W.)

6505 MEASUREMENT OF THE ELECTRON AND STAGNATION TEMPERATURES IN A LINEAR ARGON–POTASSIUM MHD GENERATOR. G. Brederlow (Institut fur Plasmaphysik, Munich), R. Eustis, and W. Riedmueller. 6p. (CONF-640701-95)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The electron and stagnation temperatures were measured in a linear, segmented-electrode MHD generator using argon seeded with potassium. The results were compared with theoretical predictions. (D.C.W.)

6506 EXTRA-THERMAL IONIZATION AND MHD FLOWS. A. Sherman (General Electric Co., Philadelphia) and H. Yeh. 10p. (CONF-640701-107)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

Channel flow with extra-thermal ionization is analyzed, using a modified Ohm's law to incorporate the effect of such ionization into the macroscopic MHD equations. The production of extra-thermal ionization by applied electric fields with ionization electrodes located within the generator is proposed. The effect of electrode geometry on net power output is calculated. (D.C.W.)

6507 MPD POWER GENERATION UNDER CONDITIONS COMPATIBLE WITH MAGNETICALLY INDUCED NON-EQUILIBRIUM IONIZATION. M. E. Talaat (Advanced Power Tech. Co., Inc., Bethesda, Md.). 10p. (CONF-640701-109)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The equations for MHD power generation are solved under conditions compatible with non-equilibrium ionization. Formulas are obtained for the power density in the MHD duct, the power extraction efficiency, and the dimensions of the duct. Closed-cycle generation in which the reject heat from the duct is used to power the compressor is evaluated. (D.C.W.)

6508 A GENERALIZED APPROACH TO CLOSED-CYCLE MHD FLUIDS. W. S. Emmerich and R. E. Voshall (Westinghouse Research and Development Center, Pittsburgh). 5p. (CONF-640701-47)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The effect of gas pressure on the design of MHD channels was studied, with specific consideration of the pressure required to provide the necessary electron mobility. The channel length and power of a segmented-electrode generator were obtained for different gases and gas pressures. The parameters of a lithium Rankine-cycle generator were evaluated, considering photoionization as the mechanism for production of nonequilibrium ions. (D.C.W.)

6509 PERFORMANCE PREDICTION OF MHD GENERATORS OVER A WIDE RANGE OF MAGNETIC FIELDS. T. C. Tsu (Westinghouse Research Labs., Pittsburgh). 10p. (CONF-640701-48)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The performance of Hall and segmented-electrode MHD generators was investigated as a function of magnetic field strength, using current equations that include Hall effect on the ions as well as the electrons. (D.C.W.)

6510 A STUDY OF CLOSED CYCLE MPD POWER GENERATOR COMPATIBLE WITH JET COMPRESSION. Cheng Shih (Martin Marietta Corp., Baltimore). 11p. (CONF-640701-46)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

A treatment is presented of the relation of velocity and temperature distribution, cross-sectional area variation, length, power output, thermodynamic efficiencies and power density with respect to inlet and exit Mach numbers of ideal Faraday-type MPD generators with segmented electrode pairs normal to the magnetic field and the flow path operating under a constant pressure thermodynamic process. Results for some of the performance characteristics for generators operating with constant electrical loading factor

and constant current density for a fixed exit Mach number 0.2 and for generators operating with constant output voltage for a fixed exit Mach number of 0.6 are presented. A comparison of these results with results obtained elsewhere showed that the constant pressure generator is superior to the constant area generator in both thermodynamic efficiencies and power densities except in the constant current density mode. (auth)

6511 OPTIMIZATION OF LARGE SCALE NUCLEAR MPD SYSTEMS. B. C. Lindley and I. R. McNab (International Research and Development Co., Ltd., Newcastle-upon-Tyne, Eng.). 11p. (CONF-640701-53)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The effects of the inlet Mach number and the reactor operating pressure on the specific power of segmented-electrode MPD generators using Ar–Cs and He–Cs mixtures with thermal equilibrium and with magnetically induced nonthermal ionization were analyzed. (D.C.W.)

6512 EFFICIENCY OF CLOSED LOOP MHD GENERATORS UTILIZING THERMAL NON-EQUILIBRIUM IONIZATION. E. Jenny, M. Rosner, and H. Nabholz (Brown, Boveri and Co. Ltd., Baden, Switzerland). 11p. (CONF-640701-50)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The relation between the overall efficiency of a closed-cycle MHD generator-steam plant system and the peak temperature and machine efficiency of the MHD section was studied, and criteria for the layout of the best possible MHD generator were established. Specifically, the pressure at which the required machine efficiency can be attained with a preset inlet temperature was investigated. (D.C.W.)

6513 MPD EXPERIMENTS WITH A HELIUM–CESIUM LOOP. B. C. Lindley, R. Brown, and I. R. McNab (International Research and Development Co., Ltd., Newcastle-upon-Tyne, Eng.). 16p. (CONF-640701-52)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

A closed-cycle MPD loop was developed in which gas temperatures to 2500°K are provided by an electric resistance heater. Preliminary experiments with Cs-seeded He indicated electrical outputs at least equivalent to thermal ionization. Magnetically-induced extra-thermal ionization may not occur under the particular conditions which apply, the electron density being less than a threshold value. (D.C.W.)

Elementary Particles and Radiations

Refer also to abstract 6635.

6514 (CEA-R-2525) TENTATIVE DE MISE EN EVIDENCE DU MODE DE DESINTEGRATION $\rho^+ \rightarrow \pi^+ + \gamma$. (Tentative Observation of the $\rho^+ \rightarrow \pi^+ + \gamma$ Decay Mode). Alice Daudin, Marie-Antoinette Jabiol, Claude Kochowski, Claude Lewin (France. Commissariat à l'Énergie Atomique. Centre d'Étude Nucléaires, Saclay), Salverio Mongelli, Aldo Romano, and Pedro Waloschek (Bari, Italy. Universita. Istituto di Fisica). July 1964. 8p. Dep.(mn).

One of the purposes of the 1.6 Bev/c π^+ p experiment, carried out in the 50 cm Saclay hydrogen bubble chamber, was to observe the $\rho^+ \rightarrow \pi^+\gamma$ radiative decay mode in $\pi^+p \rightarrow \pi^+p\gamma$ interactions. A 6 mm thick lead plate, set at the outgoing part of the chamber, was used to convert γ into e^+e^-. Among the γ observed arising directly from the investigated interactions, no event originates from a $\pi^+\gamma$ compound in the region of ρ^+. This gives an upper limit of 2 per cent for the branching ratio $(\rho^+ \rightarrow \pi^+\gamma)/(\rho^+ \rightarrow \pi^+\gamma + \rho^+ \rightarrow \pi^+\pi^0)$. (auth)

6515 (JINR-E-1813) A MEASUREMENT OF THE REAL PART OF THE ELASTIC π^--p SCATTERING AMPLITUDE AT 3.5 Gev. V. A. Nikitin, A. A. Nomofilov, V. A. Sviridov, L. A. Slepets, I. M. Sitnik, and L. N. Strunov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1964. 9p. Dep.(mn).

The results of measurements of elastic π^-–p scattering cross section are presented, for the angle range where the interference of this scattering with Coulomb scattering is essential ($1.22 \cdot 10^{-3} \leq t \leq 4.22 \cdot 10^{-3}$ Bev^2/c^2). The magnitude and the sign of the real part of the scattering amplitude are determined from the interference effect. The value of ReA = −0.33 ImA obtained is compared with that calculated from the dispersion relations. (auth)

6516 (JINR-P-1715) URAVNENIE BETE-COLPITERA V SIMMETRICHNOI MEZONNOI TEORII. (The Bethe-Salpeter Equation in Symmetric Meson Theory). Ya. Kvetsin'ski and P. Shurai'i (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 18p. Dep.(mn).

Some rearrangement of the terms of the perturbation theory is proposed. Three-particle vertices appear instead of the initial four-particle ones. With the help of this rearrangement it is shown, in any order of perturbation expansion of the kernel of the Bethe-Salpeter equation, that the kernel satisfies the Fredholm condition. The asymptotic behavior of the leading Regge pole is found. (auth)

6517 (JINR-P-1778) PARAMETR MISHELYA V $\mu^- \rightarrow e^-$-RASPADE. (Michel Parameter in the $\mu^- \rightarrow e^-$ Decay). D. B. Pontekorvo and R. M. Sulyaev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1964. 10p. Dep.(mn).

The energy spectrum of electrons produced by the decay of negative muons from the helium mesic atom states is obtained. The momenta of 4090 electrons are measured. A helium-filled diffusion chamber at 20 atm pressure was used in the experiment. The Michel parameter calculated by least squares turned out to be 0.867 ± 0.035. (auth)

6518 (JINR-P-1807) ISSLEDOVANIE REZONANSOV V SISTEMAKH STRANNYKH CHASTITS I $\pi^\pm$-MEZONOV. CHAST I. BARIONNYE REZONANSY. (An Investigation of Resonances in the Systems of Strange Particles and π^+, π^- Mesons. Part I. Baryon Resonances). V. A. Belyakov, V. I. Veksler, N. M. Viryasov, E. N. Kladnitskaya, G. I. Kopylov, V. N. Penev, and M. I. Solov'ev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). Dep.(mn).

The production and properties of the resonances decaying into Λ hyperons and $\pi^\pm$ mesons were investigated. The data on the production cross sections of $Y^+(1385$ and $Y^+(1660)$ hyperons in π^-–p interactions at 7.5 Bev/c are given. The properties and the characteristics of the $Y^+(1385)$ hyperon production and its decay products are investigated. The maximum in the $M_{\Lambda\pi^+\pi^-}$ spectrum for the mass of about 1770 Mev is discussed. (auth)

6519 (JINR-P-1814) FORMULY PRIVEDENIYA I PREDSTAVLENIYA DLYA AMPLITUD n-UGOL'NYKH DIAGRAMM. (The Reduction Formulas and Representations for the Amplitudes of n-Angular Diagrams). B. N. Valuev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 8p. Dep.(mn).

Formulas are obtained that describe the arbitrary n-angular diagrams (for zero-spin particles), in terms of the amplitudes of (n-1)th order and of definite functions of the variables characterizing the diagram. By making use of the deduced formulas, the amplitude of any n-angular diagram can be written down in the symmetrical form as a single integral over the parameter. (auth)

6520 (SLAC-25(Pt.II)) 1963 SUMMER STUDY REPORT. PART TWO. L. Hand and R. Wilson (Cambridge Electron Accelerator, Mass.). Contracts AT(04-3)-400 and AT(04-3)-476. 73p. Dep.; $3.00(cy), 2(mn) OTS.

Two papers are included; separate abstracts have been prepared for both. (T.F.H.)

For abstracts of individual sections see: 6521 and 6522.

6521 (SLAC-25(Pt.II)(p.1-30)) INELASTIC ELECTRON-PROTON, POSITRON-PROTON, AND MUON-

PROTON SCATTERING. L. Hand and R. Wilson (Cambridge Electron Accelerator, Mass.).

Theoretical and experimental results are reviewed on electron–proton, positron–proton, and muon–proton interactions. (T.F.H.)

6522 (SLAC-25(Pt.II)(p.31-68)) ELECTROPRODUCTION AT SLAC. L. Hand (Cambridge Electron Accelerator, Mass.).

The possibility of using small-angle inelastic scattering of electron beams as a source of virtual monochromatic gamma rays is discussed, as applied to the electron beam from the Stanford Linear Accelerator. (T.F.H.)

6523 PHENOMENOLOGY OF PRODUCTION PROCESSES AND THE PION RESONANCES. J. Naisse and J. Reignier (Universite Libre, Brussels and Laboratoire des Hautes Energies, Brussels). Fortschr. Physik, 12: 523-65(1964).

An attempt was made to analyze the main phenomenological recipes that are currently used in the analysis of the complicated production processes where the meson (π) resonances are being studied. The emphasis is more on the global treatment of the reactions than on the separate analysis of the resonant subsets of particles that are believed to occur among the reaction products. The application of these methods to some of the best known examples of pion excited states is presented. (auth)

6524 THRESHOLD RESONANCES. V. N. Stairkov. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 40-7(1963). (In Russian)

An investigation was made to determine if a second type resonance, for two-section channels (pre-threshold resonances), and a third type resonance, produced by interactions of open channels (post-threshold resonances), exist. (R.V.J.)

6525 ON THE THRESHOLD ORIGIN OF INELASTIC RESONANCES. Ya. I. Granovskii, A. A. Pantyushin, and V. N. Starikov. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 48-51(1963). (In Russian)

An existence of a resonance below the new inelastic threshold was observed under certain elastic scattering conditions when the interactions in the inelastic channel were not of the resonance type. The presence or absence of a resonance depends on the internal parity of the second channel. (tr-auth)

6526 COLLISIONS OF TWO HIGH ENERGY BODIES AND THE INFLUENCE OF HEAVY PARTICLE INTERACTIONS WITH A VECTOR MESON FIELD ON THE ENERGY SPECTRA OF SECONDARY PARTICLES. M. T. Zhumartbaev. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 76-81(1963). (In Russian)

The influence of initial nucleon-antinucleon collisions on hydrodynamic system expansion and the spectrum of secondary particles produced by pair annihilation was investigated. Relativistic hydrodynamic equations were developed for particles interacting in vector meson fields. Equations for the hydrodynamic expansion of the nuclear cluster showed that the expansion time, up to the moment of disintegration into separate particles (π mesons), depends on the energy of the colliding particles. The higher the energy the longer the expansion time. At distances remote to the collision plane and at temperatures $T \ll T_0$, the influence of the initial pair collisons on cluster decay is negligible. (R.V.J.)

6527 INVESTIGATION OF MULTIPLE SCATTERING OF PROTONS IN NUCLEAR EMULSIONS AT 19.8 Bev/c. K. V. Sharapov, R. A. Tursunov, Zh. S. Takibaev, and E. G. Boos. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 94-101(1963). (In Russian)

Various particle energy evaluation methods using multiple coulomb scattering were analyzed and compared. Coordinate measurements were made on multiple scatterings in an emulsion stack irradiated with 19.8-Bev protons. A diagram was made of the distribution of measured secondary coordinates for 500, 1000, 6000, and 12000 μ cells. For $3000 < t < 6000$ μ cells the best results were obtained for D_C by the method of individual exclusion of n. For $6000 < t < 12000$ μ the best approximation was found by the method of averaged exclusion of n. In determining energy at 20 Bev the optimum cell was 6000 μ when $D^{-2}_{meas}/n^{-2} \simeq 4$ and $\rho = 1.36$ (D^{-2} is the measured root-mean-square value of the R difference of the coulomb scattering coordinate). (R.V.J.)

6528 PION DYNAMICS IN NUCLEAR MATTER. Hironari Miyazawa (Tokyo Univ.). J. Phys. Soc. Japan, 19: 1764-8(Oct. 1964).

The behavior of pions in nuclear matter is different from that of free pions due to strong interactions with nuclear particles. The modified pion propagator and π-N coupling are calculated using the static approximation for nucleons. The results indicate that the pion mass is decreased in the nucleus by about 15 Mev and the coupling constant is increased by 15%. (auth)

6529 PHOTOPRODUCTION OF POSITIVE PIONS FROM CARBON NUCLEI. Seiji Kabe, Sadayuki Kato, Tadashi Kifune, Yoshitaka Kimura, Masaaki Kobayashi, Kunitaka Kondo, Yorikiyo Nagashima, and Tetsuji Nishikawa (Tokyo Univ.). J. Phys. Soc. Japan, 19: 1800-8(Oct. 1964).

Mesons (π^+) with energies ranging from 30 to 150 Mev were produced on a carbon target by a bremsstrahlung beam from a 750-Mev electron synchrotron and were detected by a π-μ decay counter telescope. The counts were corrected for the electronic efficiency of the pion counting system and for the loss of pions in the detection system by decay in flight, nuclear absorption, nuclear scattering, and multiple Coulomb scattering. Absolute cross sections of the pion production are given as a function of the peak bremsstrahlung energies extending from 180 to 550 Mev. Applying the photon difference method to the cross section per equivalent quantum, the differential cross sections are obtained and compared with theoretical values, which are calculated on the bases of the impulse and closure approximation, the nuclear momentum distribution of a Gaussian type of the average kinetic energy of 19 Mev, and the optical model treatment of the final pion-nucleus interactions. Fair agreement between the experiment and the theory is obtained, and the results support the assumption of the initial production of pions throughout the nuclear volume. A 3-3 resonance effect is also found in the case of the bound nucleon, and no appreciable nuclear effect other than those due to the nuclear momentum distribution and final state interactions was observed. (auth)

6530 π^+-PROTON INTERACTIONS AT 500 Mev INCIDENT ENERGY. J. Debaisieux, F. Grard, J. Heughebaert, R. Servranckx, and R. T. Van de Walle (Institut Interuniversitaire des Sciences Nucleaires, Brussels). Nucl. Phys., 63: 273-85(Mar. 1965).

Results are presented on π^+-p interactions at 500 Mev from an experiment performed with the Saclay 35-cm hydrogen bubble chamber. A total of 1840 events was observed. The branching ratio for elastic events is equal to 0.883 ± 0.008. Eight events are unambiguously attributed to the $\pi^+p \rightarrow \pi^+p\gamma$. Cross sections for the various interactions are given. The elastic angular distribution was determined up to $\cos\theta = +0.975$ and shows evidence for S, P, D waves, in good agreement with the results obtained in other experiments. For the one-pion production reactions, the ratio of π^0 production to π^+ production is found to be equal to 4.1 ± 0.8. This result and the corresponding distributions for momentum and angle of the secondaries are compared with the predictions of the isobaric models. (auth)

6531 PROPERTIES OF STRANGENESS AND A MASS FORMULA FOR VECTOR MESONS. A. Petermann (CERN, Geneva). Nucl. Phys., 63: 349-52(Mar. 1965). (In French)

A mass formula for vector mesons is proposed, and the role of strangeness in mass formulas is discussed. (auth)

6532 ANTIPROTON-PROTON TOTAL CROSS-SECTIONS BETWEEN 0.575 AND 5.35 Gev/c. U. Amaldi, Jr., T. Fazzini, G. Fidecaro, C. Ghesquiere, M. Legros, and H. Steiner (CERN, Geneva). Nuovo Cimento (10), 34: 825-53(Nov. 16, 1964).

The total cross section for $\bar{p}$-p interaction was measured

at momenta between 0.575 and 5.35 Bev/c. The cross section decreases monotonically with increasing momentum. No significant irregularity was observed. (D.C.W)

6533 DIFFERENTIAL CROSS-SECTION OF THE $\pi^- + p \rightarrow \pi^0 + n$ PROCESS AT 930 Mev. A. Bigi, R. Carrara, and D. Zanello (Università, Pisa, Italy; Istituto Nazionale de Fisica Nucleare, Pisa, Italy; and Scuola Normale Superiore, Pisa, Italy). Nuovo Cimento (10), 34: 878-82 (Nov. 16, 1964).

A bubble chamber study of π-p charge-exchange scattering at 930 Mev is reported. The forward differential cross-section is derived and compared with the result obtained on the basis of dispersion relations and the charge-independence hypothesis. Satisfactory agreement is obtained. (auth)

6534 SU_3-INVARIANT SOLUTIONS TO A RECIPROCAL BOOTSTRAP MODEL. R. H. Capps (Northwestern Univ., Evanston, Ill.). Nuovo Cimento (10), 34: 932-45 (Nov. 16, 1964).

The possibility that the existing strongly interacting particles correspond to the simplest self-consistent solution of a dispersion-theoretic bootstrap model is considered. A generalization of the Chew reciprocal bootstrap model is applied to baryons. Three simple self-consistency requirements are postulated. It is shown that the Hermitean property of the unreduced elastic crossing matrix favors a low spin value for the ground-state baryon multiplet. Attention is then limited to SU_3-invariant schemes of particles. The physical, octet-decuplet particle set, known from several previous works to satisfy similar models, is a solution to the present model. The hypotheses that the ground-state baryon multiplet corresponds to an SU_3 singlet, triplet, or sextet do not lead to a solution involving fewer particles than the octet-decuplet solution. The F/D interaction angle in the octet-decuplet solution is 31.8°. There is a moderately strong attraction in the $P_{\frac{1}{2}}$ states of the representation 10* in this solution. (auth)

6535 COMPLEX ANGULAR MOMENTUM AND ENERGY IN THREE-PARTICLE AMPLITUDES. M. H. Choudhury (Univ. of Edinburgh). Nuovo Cimento (10), 34: 956-80 (Nov. 16, 1964).

The partial-wave integral equations connecting the three-particle amplitudes are derived from the Fadeev equations written in a form due to Lovelace. The kernel of these equations is studied by operator techniques to derive analyticity properties in the total energy s and in a particular continuation of the total angular momentum J (that in which the relative angular momentum between any pair of particles is kept fixed). It is found that the amplitudes are meromorphic in the product of the J and s planes except for kinematical cuts in the J-plane and the three-particle and bound-state scattering cuts in the s-plane. (auth)

6536 PRODUCTION OF A SINGLE HIGHLY ENERGETIC π^0 OR π^+ IN A PROTON-NUCLEON COLLISION. D. S. Narayan (Tata Inst. of Fundamental Research, Bombay). Nuovo Cimento (10), 34: 981-6(Nov. 16, 1964).

It is shown that the one-pion-exchange model, phenomenologically modified to incorporate the damping of large momentum transfers as well as large transverse momenta, can explain the occurrence of events reported by Dobrotin in which a single meson (π) emerges carrying away a large part of the incident energy. The same mechanism can explain the positive excess of mesons (μ) in cosmic rays at sea level and also the occurrence of the so-called meson (μ)-free showers observed by Suga. (auth)

6537 RELATIVISTIC STUDY OF THE REACTION $p + p \rightarrow d + W^+$. M. Le Bellac, F. M. Fenard, D. Schiff, and J. Tran Thanh Van (Laboratoire de Physique Théorique et Hautes Energies, Orsay, France). Nuovo Cimento (10), 34: 1096-1100(Nov. 16, 1964).

The $p + p \rightarrow d + W^+$ process was investigated in a covariant theory. The effects of deuteron structure, derivative coupling, and weak interaction form factors were studied. The differential and total cross sections were calculated for several W masses from 0.7 to 1.6 Bev and different forms for the n-p-d vertex function. (D.C.W.)

6538 POSSIBLE DETERMINATION OF PARITY OF BOSONS FROM PHOTOPRODUCTION. M. Kawaguchi (Australian National Univ., Canberra). Nuovo Cimento (10), 34: 1114-15(Nov. 16, 1964).

A method is proposed for determining the parity of spin-zero bosons from photoproduction with linearly polarized gamma rays. (D.C.W.)

6539 DYNAMICAL BASIS OF THE 960 Mev RESONANT STATE. R. C. Arnold (Univ. of California, Los Angeles). Nuovo Cimento (10), 34: 1119-21(Nov. 16, 1964).

The 960-Mev resonant state observed in the interaction $\bar{K} + p \rightarrow \Lambda^0 +$ pions was investigated on the basis of a simple dynamical model. (D.C.W.)

6540 FIRST-ORDER VIOLATION OF SU_3 INVARIANCE IN THE VECTOR AMPLITUDE OF LEPTONIC DECAYS OF STRANGE PARTICLES. C. Bouchiat and Ph. Meyer (CERN, Geneva). Nuovo Cimento (10), 34: 1122-6(Nov. 16, 1964).

Assuming that the violation of SU_3 invariance can be described by a local lagrangian which transforms like an $I = 0$, $S = 0$ member of an SU_3 multiplet, it is proved that the first-order correction to the vector decay amplitude in the limit of zero momentum transfer can be accounted for by using unrenormalized coupling constants, but with wave functions corresponding to the physical masses. The wave function correction is only of second order for the relevant matrix element; in first order there is no modification of the matrix element for the time component of the vector current. (D.C.W.)

6541 MINIMAL ELECTROMAGNETIC COUPLING OF VECTOR MESONS. S. A. Bonometto (Università, Padua and Instituto Nazionale di Fisica Nucleare, Padua). Nuovo Cimento (10), 34: 1127-30(Nov. 16, 1964).

The minimal coupling (as defined by Gell-Mann and Glashow) of the electromagnetic field with a complex vector field is studied. It is shown that if the spin-zero parts of both the electromagnetic and charged vector fields are assumed to have no physical consequences, the form of the minimal coupling is unique and involves a term of the type of an anomalous magnetic moment. (D.C.W.)

6542 LOW-ENERGY MUON SPECTRUM FROM $K_{\mu 3}$ DECAY. G. Giacomelli (Università, Bologna), D. Monti, G. Quareni, A. Quareni-Vignudelli, W. Pueschel, and J. Tietge. Nuovo Cimento (10), 34: 1134-7(Nov. 16, 1964).

The spectrum of mesons (μ) from $K^+ \rightarrow \mu^+ + \pi^0 + \nu_\mu$ with energies up to 28 Mev was obtained by exposure of Ilford K-5 emulsion to a 700-Mev/c meson (K^+) beam. The results were compared with theoretical predictions for the two values of the ratio of the strong interaction form factors. (D.C.W.)

6543 A-PARITY CONSERVATION AND MESON REACTIONS. S. Minami (Osaka City Univ.). Nuovo Cimento (10), 34: 1138-40(Nov. 16, 1964).

Meson processes in meson-nucleon interactions are discussed on the basis of A-invariance. Boson decays are briefly considered. (D.C.W.)

6544 ANALYTIC SOLUTIONS FOR NONLOCAL SINGLET-EVEN NUCLEON-NUCLEON POTENTIALS. Lee H. Schick (Univ. of Minnesota, Minneapolis). Phys. Rev., 136: B1624-32(Dec. 21, 1964). (COO-1371-2)

The two-nucleon, singlet-even potential is assumed to be an integral operator. An analytic solution to the Schroedinger equation with this potential is constructed in some regions for integral operators H_c which are functions of Hamiltonians whose eigenfunctions are known analytically. For cases where the Schroedinger equation with potential also admits an analytic solution, analytic expressions for the singlet-even phase shifts are derived. For the crude model with square cutoff factor, $U(r) = V(r)$ square, the $^1S_0$ and $^1D_2$ phase shifts for energies up to 340 Mev are evaluated. The fits obtained to the experimental phase shifts are fair. (auth)

6545 VARIATION OF BREMSSTRAHLUNG INTENSITY WITH ANGLE NEAR THE HIGH-ENERGY END OF THE SPECTRUM. R. Zdarko, D. Drickey, and R. Mozley

(Stanford Univ., Calif.). Phys. Rev., 136: B1674-7(Dec. 21, 1964).

The relative intensity of thin-target bremsstrahlung is measured as a function of bremsstrahlung angle at the high-energy end of the spectrum in the angular range from 0.0 to 3.0 mc^2/E for peak energies of E = 375 and 550 Mev. Measurements are compared with several theories. There is substantial disagreement. (auth)

6546 ANALYSIS OF p-p DATA NEAR THE INTERFERENCE MINIMUM. Martin L. Gursky and Leon Heller (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 136: B1693-1702(Dec. 21, 1964). (LADC-6012)

In the first part of this paper p-p elastic scattering data at 90°c.m. near the Coulomb-nuclear interference minimum are analyzed. The energy of the minimum of the 90° cross section is found to be at 0.38243 ± 0.00020 Mev. The nuclear s-wave phase shift, defined with respect to wave functions which solve the Coulomb plus vacuum polarization potential problem, is found to be $\delta_0^R = 0.25501 \pm 0.00020$, at the precise energy 0.38243 Mev. In the second part of the paper the phase shift just obtained is used, in conjunction with four very accurate phase shifts from 1.4 to 3.0 Mev, to determine the parameters of the s-wave effective-range expansion. If this expansion is cut off after three terms (quadratic fit) then the scattering length is found to be a = −7.815 ± 0.008F; the effective range $r_0 = 2.795 \pm 0.025$F; and the shape-dependent parameter P = 0.028 ± 0.014. However, it is argued that the first three coefficients in the actual power-series expansion of the effective-range function are not known this well, and in particular, P may be very different from the actual coefficient occurring in the k^4 term. (auth)

6547 HIGH-ENERGY INELASTIC SCATTERING OF NUCLEONS; THE DISTORTED-WAVE IMPULSE APPROXIMATION. R. M. Haybron and H. McManus (Michigan State Univ., East Lansing). Phys. Rev., 136: B1730-40(Dec. 21, 1964). (ORNL-P-157)

The effects of distorted waves on the high-energy inelastic scattering of protons by ^{12}C were investigated using the distorted-wave-impulse approximation. It was found that except for electric monopole transitions, the use of distorted waves results in a reduction of the peak differential cross section by a factor of 2 or 3, with little effect on the location or shape of the curve. It was also found that the presence of spin-orbit coupling in the distorting potential has a non-negligible effect on the proton polarization at some angles. The 2^+ level of ^{12}C at 4.43 Mev was treated in some detail in L-S and j-j coupling extremes to look at the relative effects of distortions on nonspin-flip and spin-flip matrix elements. (auth)

6548 SUPERMULTIPLETS OF ELEMENTARY PARTICLES. B. Sakita (Univ. of Wisconsin, Madison). Phys. Rev., 136: B1756-60(Dec. 21, 1964). (TID-20959)

The notion of supermultiplets is applied to the structure of elementary particles. The group structure is assumed to be SU_6. The quark model is assumed for the entire discussion, although some of these results can be obtained from other models. It is found that the octet of pseudoscalar mesons along with the octet and the singlet of vector mesons form a supermultiplet. A mass form for the vector mesons is derived. It is also found that the octet of baryons along with a singlet particle of spin $3/2$ form a supermultiplet. The type of baryonic coupling for the electromagnetic and weak current is derived. (auth)

6549 SELF-CONSISTENT CALCULATION FOR THE NUCLEON MASS, π-N COUPLING CONSTANT, AND THE LOW-ENERGY $P_{\frac{1}{2}}$, $T = \frac{1}{2}$, π-N SCATTERING PHASE SHIFTS. P. Narayanaswamy and Lalit Kumar Pande (Univ. of Delhi). Phys. Rev., 136: B1760-6(Dec. 21, 1964).

A self-consistent calculation is performed for the low-energy $P_{\frac{1}{2}}$, $T = \frac{1}{2}$, pion-nucleon scattering amplitude, using the N/D method. The distant part of the left-hand cut for the partial-wave amplitude is dealt with using pole-term approximations. The mass of the nucleon bound state is found to be ≈ 880 Mev, the coupling constant ≈ 12. The low-energy phase shifts and the scattering length are also in qualitative agreement with the observed ones. (auth)

6550 PION-NUCLEON VERTEX FUNCTIONS. Masakuni Ida (Univ. of Illinois, Urbana). Phys. Rev., 136: B1767-76(Dec. 21, 1964).

A quantitative study of the pion-nucleon vertex function with one nucleon off the mass shell is presented using dispersion-theoretical techniques. The discussion is based on the unitarity conditions for the vertex function and for the one-nucleon irreducible parts of the pion-nucleon scattering amplitudes with $I = J = \frac{1}{2}$. It is shown in terms of the N/D method that the vertex function has a sharp maximum in the low-energy region. Its existence is found to be crucial for a certain inequality, which is due to the requirement of no ghosts in the theory, to be satisfied. The nucleon propagator is strongly suppressed at the energy of this maximum. Reasonable results obtained seem to suggest that ghosts are not present in pion physics, although the present calculation is still incomplete. The pion-nucleon vertex function with pion off the mass shell is also discussed and some early attempts are re-examined. The importance of a pole or a resonance-like behavior in this vertex is suggested. (auth)

6551 A SIMPLE ABSORPTION MODEL FOR HIGH-ENERGY π-N, K-N, AND N-N SCATTERING: APPLICATION TO CHARGE-EXCHANGE REACTIONS. E. M. Henley and I. J. Muzinich (Univ. of Washington, Seattle). Phys. Rev., 136: B1783-7(Dec. 21, 1964). (TID-20778)

A simple parametrization of the high-energy π-N, K-N, and N-N scattering phase shifts is obtained. The partial-wave amplitudes are assumed to be purely imaginary. This representation is used to discuss the absorption in a peripheral-model description of charge-exchange reactions with incident pions, kaons, and nucleons. The Jacob-Wick helicity amplitudes are used to treat the spin dependence. The n-p charge-exchange differential cross section is found to be narrow, primarily because, in the presence of absorption, the pion-exchange contribution is not zero in the forward direction. In addition the angular distribution exhibits a secondary maximum at a small angle due to one of the helicity-flip amplitudes. In contrast, the π-N and K-N charge-exchange angular distributions, determined by ρ exchange, are relatively wide. (auth)

6552 ELECTROMAGNETIC FORM FACTOR OF THE NEUTRINO. Wen-Kwei Cheng and S. A. Bludman (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 136: B1787-90 (Dec. 21, 1964).

The neutrino form factor has previously been determined only to order of magnitude. For this reason and because the W mass is large (or infinite), the largest part of the neutrino form factor is determined from the charged lepton contribution using a gauge-invariant direct-interaction theory. This is obtained, without further calculation, from the photon vacuum polarization. The ν_e charge radius thus measures the same integral that appears in the perturbation-theory calculation of Z_{3e}^1, the charge renormalization in quantum electrodynamics. (auth)

6553 PERMUTATION SYMMETRIES OF TWO-BODY AMPLITUDES. D. C. Peaslee (Australian National Univ., Canberra). Phys. Rev., 136: B1807-13(Dec. 21, 1964).

Considerations of permutation symmetry among the three channels in two-body scattering suggest that only amplitudes of symmetry S are non vanishing in the forward direction at infinite energies; the other three-object symmetries A and D are not represented. For like particles the restrictions are strong and contradict the dominance of universal particle exchange at high energies; limiting cross sections will not generally be independent of isotopic spin, although this is accidentally true for NN scattering. Applications are restricted mainly to isotopic spin, although an interesting point emerges: particles with half-integer isotopic spin must also possess some other intrinsic parameter of spinor character. (auth)

6554 BOSON-POLE MODEL IN K-MESON AND η-MESON DECAYS. K. Tanaka (Argonne National Lab., Ill.). Phys. Rev., 136: B1813-16(Dec. 21, 1964).

The direct term of the decay mode $K \to \pi + \pi + \gamma$ and the decay amplitudes $K \to \pi + \pi + \pi$ and $\eta \to \pi + \pi + \pi$ are obtained on the basis of the boson-pole model to all orders in

the strong interaction, provided the interaction (except for the weak vertex) is SU_3-invariant. The weak vertex is assumed to transform as K°. Then all $K \to \pi + \pi + \gamma$ modes, except $K_2^0 \to \pi^+\pi^-\gamma$, and all $K \to \pi + \pi + \pi$ and $\eta \to \pi + \pi + \pi$ modes except $(\eta|\pi^+\pi^-\pi^0)$, are shown to vanish. It is concluded that the boson-pole model together with unitary symmetry is untenable for $K \to 3\pi$ decay modes. (auth)

6555 MEAN LIFE OF THE NEUTRAL π MESON. Hla Shwe, Frances M. Smith, and Walter H. Barkas (Univ. of California, Berkeley). Phys. Rev., 136: B1839-47(Dec. 21, 1964).

The π^0 mean life is measured using a method that utilizes the relativistic flight-path dilation produced by a high pion velocity. A π^- beam of 3.5 Bev/c made interactions in Ilford K.5 emulsion. Some 103 secondary neutral pions were observed to decay by the Dalitz mode $(\pi^0 \to e^+ + e^- + \gamma)$ in a study of 3600 such stars. The π^0 path lengths could be accurately measured and were automatically calculated by specially developed equipment. The π^0 momentum spectrum is assumed to be the same as that of the secondary charged pions found by multiple-scattering measurements. The mean transverse momentum of secondary charged pions at all angles is 274 ± 10 Mev/c. The opening-angle distribution of the electron pairs was measured and compared with extensive calculations of the expected laboratory-system distribution in order to evaluate the number of unobserved events. A statistical approach is used to evaluate the mean life (τ_{π^0}) of the π^0. To evaluate the complex effects of electron scattering, the finite grain size, and the random grain spacing, pairs of electron tracks were generated artificially by a Monte Carlo program and the results compared with the observations. The neutral-pion mean life is estimated as $(1.7 \pm 0.5) \times 10^{-16}$ sec. (auth)

6556 ON THE $\pi\omega$ (1220) RESONANCE AND THE $K_2^0K^+\pi^+$(1410) RESONANCE. Chong-shou Gao (Peking Univ.). Sci. Sinica (Peking), 13: 1861-4(Nov. 1964).

The observed properties of the $\pi\omega$-resonance B with mass near 1220 Mev and the $K_2^0K^+\pi^+$ resonance (called A) with mass near 1410 Mev are discussed. Possible assignments of isospin, spin, parity, and G-parity are made. (C.E.S.)

6557 RELATIVISTIC FUNCTIONAL METHOD OF TREATING STRONGLY COUPLED FERMION FIELDS. G. Heber and A. Kuehnel (Universität, Leipzig). Z. Naturforsch., 19a: 1245-53(Nov. 1964). (In German)

A practical method for the calculation of Green's functions from the Lagrangian of a fermion field was developed, which works in a Lorentz-invariant manner and allows strong couplings (or nonlinearities) to also be treated. The essential point is the use of the values for functional integrals over the fermion field calculated in lattice space. The way in which the anticommutativity of the fermion field appears in the result is discussed. There are two controls in the calculations: the result of the integration must fulfill some functional differential equations and the result should coincide in one trivial, well-known example (free field) with the exact result. The result fits both controls. Only the general aspects of the problem are presented explicitly and they are applied (in order to illustrate and to control the same scheme) to the calculation of the 2-point function of a free fermion field, in which the mass term is split artificially into two parts. One of the parts is handled together with the free Lagrangian, the other one is treated as an "interaction." The use of graphs also proved to be very useful. Applications are being made to other cases. (auth)

6558 OBSERVATION OF ELECTRON SHOWERS AT GREAT ELECTRODE DISTANCES (15 cm) IN AIR. C. Driver (Universität, Hamburg). Z. Naturforsch., 19a: 1327-8(Nov. 1964). (In German)

Electron showers and their development were investigated for electrode discharges in air with the help of a photomultiplier. A copper electrode (cathode) and an aluminum slate (anode) served in the electrode arrangement. Multiplier oscillograms of the electron showers are presented. A mechanism for shower production at great electrode distances is suggested. (M.C.G.)

6559 A NOTE ON MESON–BARYON SCATTERING. T. Roy (Jadavpur Univ., Calcutta). Z. Physik, 182: 4(1964).

Meson–baryon scattering in the unitary symmetry scheme along the line of the static–Chew model from which candidates for resonances can be sorted out is discussed. (C.E.S.)

6560 DEVELOPMENT OF SCATTERING AMPLITUDES ACCORDING TO IRREDUCIBLE SPIN-TENSOR OPERATORS. Alfred Koerding (Technische Hochschule, Darmstadt, Ger.). Z. Physik, 182: 34-57(1964). (In German)

The scattering amplitude for elastic or inelastic scattering of nonrelativistic particles with spin is calculated from the angular momentum representation of the S-matrix. Application of Racah algebra techniques allows a representation in terms of irreducible spin-tensor operators. Only two particle channels are considered. The physical significance of the invariant expansion coefficients of that representation is illustrated in the well known case of nucleon-nucleon scattering. (auth)

6561 MESON-BARYON SCATTERING WITH SU(3) INVARIANT INTERACTIONS. Julius Wess (Universität, Vienna). Z. Physik, 182: 64-75(1964).

The static model invariant under SU_3 is discussed. The baryons and mesons are assigned to the eightfold way, and the Low equation for the scattering matrix is derived. The scattering matrix was diagonalized for arbitrary mixing of F- and D-type coupling and the crossing matrix was calculated. To determine the mixing of the two couplings photoproduction cross sections were calculated. From the comparison of the $K^+\Lambda$ and $K^+\Sigma_0$ production cross sections with experiment it follows that $\alpha = D/F = 3.5$. For this value of α the model predicts the $^3/_2$ decuplet resonance in very good agreement with the experimental situation. (auth)

6562 ANALYSIS OF THE PHOTOPRODUCTION OF PIONS BY MEANS OF FIXED t DISPERSION RELATIONS. [PART] I. Winfried Schmidt (Technische Hochschule, Karlsruhe, Ger.). Z. Physik, 182: 76-92(1964).

An absolute prediction for the photoproduction of pions on protons is given in the region of the first pion nucleon resonance. The imaginary part of the amplitude was approximated by the resonant magnetic dipole amplitude M_{1+}^3, taken from the theory of CGLN. With this approximation the real part of the amplitude was calculated by means of fixed t dispersion relations and discussed in terms of multipoles. π^+- and π^0-excitation curves at $\theta = 90°$ for unpolarized as well as plane-polarized γ's are compared with the experiments. Tables of the differential cross sections in the c.m. system are given. (auth)

6563 THE EIGHTFOLD WAY. Murray Gell-Mann and Yuval Ne'eman. Frontiers in Physics Series. New York, W. A. Benjamin, Inc., 1964. 326p.

Research papers dealing with the classification of strongly interacting particles and their interactions according to the eightfold way are presented. The history of strong-interaction symmetries, broken symmetry and the mass formula, the decimet and the omega-minus, assignments of supermultiplets, ϕ- ω mixing, intensity rules, electromagnetic interactions of the hadrons, triplets and triality, the weak current of the hadrons, the nonleptonic weak interaction, broken symmetry and the bootstrap hypothesis, and the physical uniqueness of the eightfold way are discussed. Thirty papers are included. (C.E.S.)

6564 ($\bar{K}$p) INTERACTIONS FROM 1-3 Bev/c. J. Button-Shafer (Univ. of California, Berkeley). 46p. (CONF-452-61)

From American Physical Society, Washington, D. C., Apr. 1964.

Data on $\bar{K}$-p interactions yielding final states which contain hyperons and hyperon resonances were analyzed. The cross sections for production of hyperon final states and resonances are discussed. The analyses for Y*(1385-Mev), Y*(1660-Mev), hyperons (Ξ^-), and the Ξ-K-π system are considered in some detail. A multi-pion, 959-Mev resonance was found. (D.C.W.)

Field Theory and Quantum Mechanics

6565 (JUL-193-PP) ONE-DIMENSIONAL FIELDS AND ADIABATIC INVARIANCE. Karl Schindler (Kernforschungsanlage. Institut für Plasmaphysik, Jülich, Germany). Sept. 1964. 57p. Dep.(mn).

The adiabatic invariance properties of the single particle motion are studied for a class of one-dimensional fields. If the fields are sufficiently smooth the theory of the (nonlinear) one-dimensional oscillator applies, which immediately leads to the result that the action integral is an adiabatic invariant to all orders in ϵ, the reciprocal time scale of the field. Some situations of physical interest, however, require a special treatment because the fields show some lack of smoothness. Two examples are discussed, fields having jump discontinuities, and small-scale fields superimposed on a constant magnetic field. In both cases adiabatic invariance of J is established. The results are discussed from several physical points of view as plane collision-free shocks, single particle acceleration, guiding center stability, and adiabatic compression. (auth)

6566 STUDY OF THE COMPLETE CHARACTER OF SOLUTIONS OF THE SCHROEDINGER EQUATION IN THE PLANE OF THE COMPLEX ANGULAR MOMENTUM. Guy Burdet, Jacques Dufour, and Maurice Giffon (Université, Lyon). Compt. Rend., 259: 2369-71(Oct. 12, 1964). (In French)

A relation of closing in the plane of the complex angular momentum showing the complete character of the ensemble of the Jost solutions of the Schroedinger equation modified by the factor r^{-1} was established. (tr-auth)

6567 GENERALIZED LORENTZ TRANSFORMATION. P. Burcev (Univ. of Brno). Czech. J. Phys., 14: 824-30(1964).

A nonlinear transformation of the coordinates connecting an arbitrary system, in which the motion of the test particle is given, with a system connected with the the test particle is derived within the framework of the general theory of relativity. The transformation contains the Lorentz transformation as a special case. Transformations are written for some special cases of non-inertial motion of a test particle. (auth)

6568 A NEW INTERPRETATION OF SU(n). Toshiyuki Toyoda (Istituto di Fisica Galileo, Padua). J. Phys. Soc. Japan, 19: 1757-8(Oct. 1964).

A new interpretation of the infinitesimal generators of the special unitary group SU(n) is proposed. A mathematical equivalence between the generators and the permutation operators of two states including sign-change operators is proved. An application of this method to SU(4) is given. (auth)

6569 IDENTITIES AND LAWS OF MOTION DEDUCED FROM A LAGRANGIAN. APPLICATION TO THE DEFINITION OF ENERGY-MOMENTUM IN A EUCLIDEAN THEORY OF GRAVITATION. S. Lederer and M. A. Tonnelat (Université, Paris). Nuovo Cimento (10), 34: 883-900 (Nov. 16, 1964). (In French)

In a phenomenological linear theory of gravitation, following the lagrangian method, the formulation of the energy-momentum conservation law, by means of the eulerian metrical tensor (rather than the usual canonical tensor) leads to the same formal results as general relativity: principle of geodesics and mass conservation. An expression for the eulerian metrical tensor is given. (auth)

6570 ON THE SUPER-ENERGY TENSOR OF AN ELECTROMAGNETIC FIELD. M. Chevreton (Université, Paris). Nuovo Cimento (10), 34: 901-13(Nov. 16, 1964). (In French)

A four-index tensor similar to the super-energy tensor of the gravitational field is introduced for the Maxwell field in two different ways: study of conserved tensors in the theory of particles with spin and study of the super-energy tensor of the five-dimensional space of Kaluza-Klein. Analogies between gravitation, electromagnetism, and classical mechanics are also examined. (auth)

6571 THE STRUCTURE OF RENORMALIZATION CONSTANTS. A. Visconti and Y. Le Gaillard (Faculté des Sciences, Marseille). Nuovo Cimento (10), 34: 914-31 (Nov. 16, 1964).

An attempt is made to find the most general form of the divergent terms that can be eliminated by means of the renormalization constants in the case of a renormalizable quantum field theory. (D.C.W.)

6572 BROKEN SYMMETRIES AND THE ELECTRON-MUON PROBLEM. Th. A. J. Maris, V. E. Herscovitz, and G. Jacob (Universidade do Rio Grande do Sul, Pôrto Alegre, Brazil). Nuovo Cimento (10), 34: 946-55(Nov. 16, 1964).

The fermion propagators in the quantum electrodynamics of the combined fields of electrons and muons with zero bare masses are investigated. The basic theory possesses various symmetry properties which are not present in the vacuum. This results in a non-uniqueness of the mathematical description and equivalence classes for the fermion propagators are defined. In the approximation used it is shown that a meaningful vacuum correlation of the two lepton fields is incompatible with an exactly parity-invariant vacuum. (auth)

6573 THE SINGULARITIES OF ASYMPTOTIC QUANTUM FIELD THEORY. J. C. Stoddart (Syracuse Univ., N. Y.). Nuovo Cimento (10), 34: 1073-95(Nov. 16, 1964).

It was shown recently that the LSZ formulation of quantum field theory can produce finite solutions for the S-matrix elements to all orders in perturbation theory. These solutions for the scattering of an arbitrary number of scalar bosons are examined in momentum space, and their singularity structure is found. It is shown that the extension off the mass shell, as carried out by Pugh of the fundamental LSZ equations, yields solutions which are the continuation of the right-hand side of the unitarity relation, $R + R^{+} = R^{+}R$ to unphysical off-mass-shell regions. The analytic mass-shell amplitudes are constructed using the unitarity condition and this continuation. By induction it is shown that the perturbation solutions of asymptotic quantum field theory possess in any order only the singularities which are required by unitarity. These were shown by Stapp to correspond to the Landau singularities of ordinary quantum field theory. (auth)

6574 A GENERAL ANALYSIS OF THE REDUCTION OF THE DIRECT PRODUCT OF TWO IRREDUCIBLE REPRESENTATIONS OF SU_3 AND OF ITS MULTIPLICITY STRUCTURE. B. Preziosi, A. Simoni, and B. Vitale (Istituto Nazionale di Fisica Nucleare, Naples and Università, Naples). Nuovo Cimento (10), 34: 1101-13(Nov. 16, 1964).

General formulas are given for the total number of irreducible representations and for the number of inequivalent irreducible representations present in the reduction of the direct product of two irreducible representations of SU_3, (p,q) and (p′,q′). The structure of the multiplicity of the irreducible representations so obtained is analyzed and shown to obey a simple and very symmetric rule. A special case is then studied in detail, namely that in which $p \geq p' + q'$, $q \geq p' + q'$; in this case, the irreducible representation (p′,q′) alone determines completely the number of irreducible representations and that of inequivalent irreducible representations. It is further shown that, in this special case, the multiplicity structure of the direct product can be brought to coincide with the multiplicity structure of the weights contained in (p′,q′). (auth)

6575 ALMOST LOCAL FIELD THEORIES OF THE S MATRIX. R. F. Streater (Imperial Coll. of Science and Tech., London and Univ. of Wisconsin, Madison). Phys. Rev., 136: B1748-55(Dec. 21, 1964).

The axioms of local quantum field theory are replaced by the following rather weaker demands: the field A(x), when integrated with a test function, is an unbounded operator in Hilbert space; the field transforms covariantly under a representation U(a,A) of the Poincaré group which is unitarily equivalent to the representation $U_0(a,A)$ in a theory of free

particles; the field is almost local in the sense of Haag. It is argued that any field satisfying these axioms has a well-defined S matrix which is unitary below the threshold for production processes. The condition that a field is "almost local" is expressed in terms of the Wightman functions of the theory. These conditions can be written down and solved for successively higher Wightman functions for successively larger regions in momentum space; at each stage the problem is well defined with no problems of convergence. A possible connection with Lagrangian theory is given. To illustrate the method the 4-point function is examined in detail below the threshold for production processes. It is found that a necessary condition for "almost locality" is that the scattering amplitude satisfy unitarity in the elastic region. Sufficient conditions in the elastic region are also given. A similar analysis can be carried through for two-channel elastic scattering, and again unitarity appears as a statement of "almost locality." (auth)

6576 EXPERIMENTAL RESTRICTIONS ON NE'EMAN'S FIFTH INTERACTION. D. Beder, R. Dashen, and S. Frautschi (California Inst. of Tech., Pasadena). Phys. Rev., 136: B1777-82(Dec. 21, 1964).

Recently, Ne'eman (Phys. Rev. 134: B1355(1964)) has proposed a "fifth interaction" between the strangeness current and a neutral vector meson χ, for the purpose of breaking SU(3) symmetry. It is shown that a χ mass less than $2m_\pi$ would be inconsistent with a variety of experiments, including K-mesonic atoms, the long-range pp potential, K_1 regeneration from a K_2 beam, the Lamb shift, modern refinements of the Cavendish "ice-bucket" experiment, and the absence of $\pi^0 \rightarrow \gamma + \chi$ and $\chi \rightarrow e^+ + e^-$. The remaining possibility, that m_χ exceeds $2m_e$, is discussed briefly. (auth)

6577 HIGHER ORDER POLES IN THE S MATRIX. R. J. Eden and P. V. Landshoff (Cambridge Univ., Eng.). Phys. Rev., 136: B1817-20(Dec. 21, 1964).

A method is developed for studying the possibility of a coincidence of more than one complex pole of the S matrix so as to produce a higher order pole. It is shown thereby that complex higher order poles may be consistent with generalized unitarity, although a real higher order pole is not consistent with physical unitarity. Also discussed is the relevance of higher order poles, and of a group of simple poles, to the Wigner time-delay formula. (auth)

6578 FIELD THEORY OF MATTER. [PART] II. Julian Schwinger (Harvard Univ., Cambridge, Mass.). Phys. Rev., 136: B1821-4(Dec. 21, 1964).

A qualitative dynamical interpretation is given for observed regularities of nonleptonic phenomena in strong, electromagnetic, and weak interactions. (auth)

6579 QUASIPARTICLES AND PROJECTION OPERATORS. W. Tobocman (Case Inst. of Tech., Cleveland). Phys. Rev., 136: B1825-30(Dec. 21, 1964).

A formal procedure for expressing the T matrix in terms of a reduced T matrix is developed. The reduced T matrix results when the original interaction or propagator which appears in the T-matrix integral equation is replaced by a reduced interaction or propagator. This reduction procedure provides a very neat derivation of the projection-operator formalism and the quasiparticle formalism. The two formalisms are compared. The projection-operator formalism appears to offer some advantages over the quasiparticle formalism. The expressions that appear have a more direct physical interpretation. For the bound-state problem, the projection-operator formalism leads to a perturbation expansion for the energy which is a generalization of the perturbation expansion. For the problem of using an elementary-particle state to represent a bound state of the system, the projection-operator formalism leads to an exact correspondence instead of the approximate one provided by the quasiparticle formalism. From this result it is concluded that the bound state and the elementary-particle state are completely equivalent ways to describe a discrete state of a system. (auth)

6580 THEORY OF HIDDEN VARIABLES. David Kershaw (Harvard Coll., Cambridge, Mass.). Phys. Rev., 136: B1850-?(Dec. 21, 1964).

It is shown that the stationary states of the nonrelativistic Schroedinger's equation are just the stationary states of a classical-mechanical system which is subject to random submicroscopic fluctuations of position. The proof covers the cases of a single particle moving in a potential, and of two particles interacting through a potential $V(x_1 - x_2)$. The results can be easily generalized to the case of n interacting particles. (auth)

6581 MASSIVE SPHERES IN GENERAL RELATIVITY. H. Bondi (London Univ.). Proc. Roy. Soc. (London), Ser. A, 282: 303-17(Nov. 24, 1964).

The exact relativistic form of the equation of hydrostatic support by an isotropic pressure is found in an especially convenient form. A quantity u, the natural generalization of Schwarzschild's m/r ratio at the surface, is used; and it is proved that the critical value u = 0.5 cannot be attained except perhaps under conditions of severe tension. It is shown that if u is everywhere less than 0.5, different physical restrictions are significant in well-defined inner and outer zones as far as the attainment of high u values is concerned. A number of limiting configurations are derived for physically significant restrictions. In particular it is shown that if the density is nowhere negative, then $u < 0.485$, while if in addition the density is nowhere less than three times the pressure and nowhere increasing outwards, then $u \leq 0.319$. (auth)

6582 ENERGY AND MOMENTUM IN GENERAL RELATIVITY. I. THE 4-MOMENTUM EXPRESSED IN TERMS OF FOUR INVARIANTS WHEN SPACE-TIME IS ASYMPTOTICALLY FLAT. F. H. J. Cornish (Univ. of Leeds, Eng.). Proc. Roy. Soc. (London), Ser. A, 282: 358-71(Nov. 24, 1964).

A derivation is given of a class of pseudo-tensor conservation equations including those due to Einstein and Landau & Lifshitz. When space-time is asymptotically flat, the asymptotic form of the metric is taken as the metric of a flat background space-time, and all events are mapped on to this background. In the map the conservation equations may be written as tensor equations, and from them invariant integral conservation laws are derived. The conservation laws are used to suggest possible invariant expressions for the components of the 4-momentum on a 3-flat in the map and to distinguish between radiating and non-radiating systems. When certain conditions are satisfied, it is shown that the total 4-momentum on a 3-flat is the same whichever conservation equation is taken as the basis of the theory. The theory based on the Landau-Lifshitz conservation equation is regarded as physically more useful than the other forms as it alone leads easily to six further invariants which are related to the angular momentum. (auth)

6583 ENERGY AND MOMENTUM IN GENERAL RELATIVITY. II. THE TOTAL ENERGY AND MOMENTUM OF AN ISOLATED AXI-SYMMETRIC SYSTEM GENERATING GRAVITATIONAL WAVES. F. H. J. Cornish (Univ. of Leeds, Eng.). Proc. Roy. Soc. (London), Ser. A, 282: 372-9(Nov. 24, 1964).

A theory in which the components of the total 4-momentum of a system are given in terms of four invariant integrals is applied to the axi-symmetric solution of the general relativity field equations for an isolated system generating gravitational waves obtained by Bondi, van der Burg & Metzner. It is shown that the total energy of the system agrees exactly with the definition of mass adopted by these authors. An expression is obtained for the total momentum along the axis of symmetry. A Schwarzschild system in uniform motion is considered as an example of non-radiative motion. (auth)

6584 CLASSICAL MOVEMENT OF PARTICLES IN ARBITRARY TENSORIAL FIELDS. N. J. Ionescu-Pallas (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 191-9(1964). (In French)

The possibility is studied of the existence of a theory of gravitation in Minkowski space. To this end, the following fundamental axioms are considered: the existence of a stationary action principle, from which may be derived either the field equations or the equations of motion; linearity of

the field equations; and representation of the source potential by a tensor of definite order. With these conditions, it is concluded that no solution can be found that satisfies all the three crucial tests for gravitation (viz. red shift, bending of light rays, and planetary perihelion precession.) (tr-auth)

6585 THE ALLOWED REGIONS OF CHARGED PARTICLES MOVING IN A MAGNETIC FIELD. Yung-lan Shu, Gou-chen, and Jeou-Jang Jaw. Sci. Sinica (Peking). 13: 1835-42(Nov. 1964).

The allowed regions of a single charged particle moving in a magnetic field with potential of axial symmetry are investigated. The theoretical calculation shows that the boundary of these regions should coincide with the magnetic lines as long as certain specific conditions are satisfied. In such cases the motion of the charged particles can be studied simply by means of the form of the magnetic lines. The theoretical results are compared with those of the terrella experiment, under the consideration that the glow and dark regions of the gaseous discharge correspond respectively to the allowed and forbidden regions. When the magnetic moment of the terrella is greater than a critical value, the glow will be confined within a toroidal region resembling the radiation belt, and the trapped electrons in the dipole field are experimentally demonstrated. The variation of the trapped region during magnetic disturbance is examined by the help of a properly prepared Helmholtz coil and ring current, and the results appear to agree with the theoretical calculations. Here the boundary of the disturbed trapped region again accords with the magnetic lines. (auth)

Geophysics

6586 (NP-14518) REFRACTION SEISMIC SURVEY — PORPOISE AREA. C. B. Forbes and C. L. Heald (United ElectroDynamics, Inc., Pasadena, Calif.). July 1961. Project 7.4A of Operation PORPOISE. 26p. (VESIAC-204-VU)

Two short seismic refraction profile lines were shot south of the Climax Granitic Stock in Nye County, Nevada, to map the southeast boundary fault and determine the relationships of the adjoining fault blocks. One survey line ran in a northeast-southwest direction parallel to and south of the fault. The other line ran in a southwest-northwest direction crossing perpendicularly both the fault and the first refraction line. Recordings were made simultaneously on magnetic tape and on photographic paper with primary concern given to recording first arrivals of compressional or "P" wave energy. Several distinct velocity zones are indicated by the recorded data southeast of the fault, starting with a surface lowspeed layer generally 100 to 200 feet thick having a velocity around 2700 feet per second. This probably consists of alluvial material. Immediately below are two intermediate zones of several hundred feet thickness with velocities approximately 4100 and 6500 feet per second, respectively, with indications of lateral velocity variations. This sequence is probably comprised of volcanic tuffs of the Oak Springs formation. Underlying this zone is high velocity rock having a velocity of approximately 17,000 feet per second which could represent either granite, dolomite, or other basement rock south of the fault. Computations indicate a displacement or slippage along the boundary fault exceeding 750 feet with downthrow to the southeast. The fault surface appears to dip approximately 55 degrees to the southeast. Although seismic energy transmission through some of the rocks in this area was only fair, the results appear to tie together acceptably and present a reasonably consistent picture. (auth)

6587 (RM-3830-PR) HYDROMAGNETIC SIGNALS IN THE IONOSPHERE. E. C. Field (RAND Corp., Santa Monica, Calif.). Sept. 1963. Contract AF49(638)-700. 44p. (AD-421842) $5.60 (OTS).

The equations which govern the propagation of hydromagnetic signals in a spatially inhomogeneous, multispecies, anisotropic ionosphere are derived and applied to several situations. Numerical results for the dependence of the ionospheric refractive indices on height and signal frequency are presented and discussed. Simplified model ionospheres, characterized by the refractive indices, are used to compute the ground-level magnetic signals produced by hydromagnetic waves incident normally from above upon the collision-dominated lower ionosphere. Magnetic disturbances, which were observed at great distances from the high-altitude Argus nuclear explosions, are considered and are shown to have been probably hydromagnetic in origin. Also, it is shown that, in principle, the ionosphere is capable of supporting hydromagnetic surface waves. The relevant equations for the case of propagation across the geomagnetic field lines are derived and discussed. (auth)

6588 (RM-4225) LOW-FREQUENCY HYDROMAGNETIC WAVES IN THE IONOSPHERE. Carl Greifinger and Phyllis Greifinger (RAND Corp., Santa Monica, Calif.). Oct. 1964. 47p. (AD-607253)

The propagation through the ionosphere of low-frequency (~1 cps) hydromagnetic waves is studied, considering the case of plane wave propagation in the vertical direction in the presence of a uniform magnetic field which is also in the vertical direction (so-called polar propagation). The purpose is to separate out the effects of the ionosphere on hydromagnetic disturbances propagating through it. The ionosphere is assumed to extend infinitely far in the upward direction and to terminate abruptly 80 km above a perfectly conducting flat earth. The charged particle density is assumed to be constant throughout the ionosphere, and the neutral particle density to vary exponentially with altitude. The coupled hydrodynamic and electromagnetic equations for the medium are linearized, and, with the approximations valid for low-frequency waves, the resulting system is shown to reduce to a second-order wave equation. A solution of this equation is obtained for a disturbance which is initially localized high in the ionosphere (i.e., at an altitude at which collisions of ions with neutrals can be neglected). The effects of the model ionosphere on hydromagnetic disturbances are contained in a dispersion relation. In particular, the ionosphere is found to possess certain characteristic frequencies, which appear as the roots of this dispersion relation. (auth)

6589 PROTONS FROM 40 TO 110 MEV OBSERVED ON INJUN 3. John Valerio (Univ. of California, San Diego, La Jolla). J. Geophys. Res., 69: 4949-58(Dec. 1, 1964).

The spatial distributions and time behavior of 40- to 110-Mev trapped protons were observed for approximately nine months. Time decay was observed only at the lower edges of the inner belt; extremely stable intensities were observed elsewhere in the region $R < 1.5$ earth radii. Assuming that an equilibrium proton distribution is established from albedo neutron injection and Coulomb energy loss with the atmosphere, the omnidirectional flux expected from 40 to 110 Mev is calculated for lines of force labeled by $L = 1.25$ and 1.50. The ratio of the observed unidirectional flux to the calculated value provides a measure of the fraction of neutron decay protons that are trapped. (auth)

6590 THE ANALYTIC DESCRIPTION OF THE GEOMAGNETIC FIELD AT SATELLITE ALTITUDES. F. T. Heuring (Johns Hopkins Univ., Silver Spring, Md.). J. Geophys. Res., 69: 4959-68(Dec. 1, 1964).

The Vanguard 3 scalar magnetic values were compared with values of the geomagnetic intensity as calculated using various sets of harmonic coefficients (ten in all). Both the arithmetic mean and the ratio of the rms difference (calculated intensity minus observed intensity) to the rms of the observed intensity were calculated. The ratio was calculated as a function, sequentially, of the number of harmonic coefficients in order to assess the contribution of each coefficient to the total magnetic intensity. The results show that not only can a "best" set of harmonic coefficients be proffered for describing the geomagnetic intensity at satellite altitudes, but also a minimum number of coefficients, depending on the accuracy desired. Also pinpointed were harmonic coefficients in need of revision, in

particular, $h_{\frac{1}{2}}$ and $h_{\frac{1}{3}}$; the maximum contribution to the magnetic intensity by external sources is estimated to be 10 to 26 gammas. (auth)

6591 LUNAR INFLUENCES ON THE FREQUENCY OF MAGNETIC STORMS. E. K. Bigg (Commonwealth Scientific and Industrial Research Organization, Sydney). J. Geophys. Res., 69: 4971-4(Dec. 1, 1964).

Difficulties in testing the statistical significance of lunar effects on the frequency of severe magnetic disturbances are discussed. It is shown that a valid case has not yet been made that the effects are due entirely to chance. (auth)

6592 VARIATIONS OF GEOMAGNETIC ACTIVITY WITH LUNAR PHASE. Harold L. Stolov (City Coll., New York and Goddard Inst. for Space Studies, New York) and A. G. W. Cameron. J. Geophys. Res., 69: 4975-82(Dec. 1, 1964).

An analysis of 31 years of K_p data suggests a variation of geomagnetic disturbance with lunar phase. A general increase in geomagnetic activity of about 4% begins after full moon and lasts for seven days. A general decrease in geomagnetic activity of about 4% is found for the seven days preceding full moon. A study of randomized data indicates that the probability that these variations should have occurred by chance is less than 5%. The effect is found to be associated with the K_p data derived from periods of geomagnetic quiet conditions; it is not evident in the data from disturbed periods. (auth)

6593 A MODEL FOR THE AURORAL ELECTROJETS. Rolf Bostroem (Royal Inst. of Tech., Stockholm). J. Geophys. Res., 69: 4983-99(Dec. 1, 1964).

Certain observations indicate that the auroral electrojets are confined to the auroral arcs. A model of an arc is presented in which the height variation of the auroral ionization is taken into account and vertical currents are allowed to flow. The current flow in the arc is investigated, and the electric field or wind velocity field required to drive the currents is calculated for two different cases: in one, the current flow between the auroral-zone ionosphere and the outer magnetosphere is assumed to be limited and electric fields occur along the magnetic field lines in the magnetosphere; in the other, the conductivity along the field lines is assumed to be perfect. In the first case, the electrojets are probably driven by a longitudinal electric field in the magnetosphere. In the second case, the driving electric field must be a meridional field in order to explain the observations; and strong sheet currents must flow along the field lines that connect the auroral ionosphere to the outer magnetosphere. (auth)

6594 A STUDY OF AURORAL ABSORPTION EVENTS AT THE SOUTH POLE. 1. CHARACTERISTICS OF THE EVENTS. J. K. Hargreaves, H. J. A. Chivers, and J. D. Petlock (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 69: 5001-7(Dec. 1, 1964).

Cosmic noise absorption records for a period of more than one year from the South Pole were analyzed using a standard 'event report.' There are two major regions in the diurnal pattern of absorption activity—a magnetic-night group and a magnetic-day group. The night events tend to be more intense but of shorter duration than the day events. There is a progressive decrease of intensity during both the day and night groups. These diurnal changes probably correspond to changes in the properties of the energetic particles entering the atmosphere, and these effects are clearly independent of local solar illumination conditions. (auth)

6595 A NEW VERY LOW FREQUENCY PHENOMENON—WHISTLERS TRAPPED BELOW THE PROTONOSPHERE. D. L. Carpenter, N. Dunckel, and J. F. Walkup (Stanford Univ., Calif.). J. Geophys. Res , 69: 5009-17 (Dec. 1, 1964).

A whistler phenomenon was identified through measurements at ground stations, on an Aerobee rocket between 100 and 200 km, and on the Alouette satellite at 1000 km. The phenomenon is called the 'subprotonospheric' or 'SP' whistler, since most of its path appears to be restricted to the region below about 1000 km. The first example of an SP whistler was reported by Barrington and Belrose. A large number of observations are summarized, and the basic characteristics of the phenomenon are described. Experimental results are presented which suggest that the whistler ray path is confined to the region between roughly 100- and 1000-km altitude, and that the whistler energy can echo back and forth between these levels. The SP phenomenon occurs mostly at night, typically within a few hours after sunset. SP events are often observed over a period of one or two hours in duration and, for a single Alouette pass, have been observed over a north-south range as great as 2000 km in extent. The evidence suggests that the SP phenomenon occurs mostly near sunspot minimum and at dipole latitudes greater than 45 degrees. (auth)

6596 AN EXPLANATION OF SUBPROTONOSPHERIC WHISTLERS. R. L. Smith (Stanford Univ., Calif.). J. Geophys. Res., 69: 5019-21(Dec. 1, 1964).

In recent investigations, Carpenter found a new type of low-dispersion whistler which is multiply reflected between the lower ionosphere and a region around 1000 km. An explanation is suggested, requiring the presence of hydrogen ions and a substantial tilt of the F layer. The hydrogen ions above 1000 km allow the whistler energy to be refracted through the region of transverse propagation; in the absence of the ions, such refraction would be forbidden. The hypothesis gives a lower limit for the plasma frequency near the region of refraction. (auth)

6597 PROPAGATION IN MULTICOMPONENT PLASMAS. R. L. Smith and Neil Brice (Stanford Electronics Labs., Calif.). J. Geophys. Res., 69: 5029-40 (Dec. 1, 1964).

A simple concise formulation of the problem of propagation in multicomponent plasmas with static magnetic fields is given. Application to plasmas, such as the ionosphere, containing electrons and multiple positive ions is considered. For each ionic species beyond the first, a multiple-ion resonance and a multiple-ion cutoff frequency are found for propagation perpendicular to the static magnetic field as well as a cutoff and the expected ion gyrofrequency resonance for the left circularly polarized (Alfvén) mode. Also, for each additional ion a crossover frequency is found for which the two longitudinally propagating modes and the transverse extraordinary mode have the same phase velocity. If a crossover frequency moves through the frequency of a wave propagating in a slowly varying medium, the polarization of the wave is changed from predominantly right circular to left circular or vice versa. (auth)

6598 RESONANCE EFFECTS OF ELECTROSTATIC OSCILLATIONS IN THE IONOSPHERE. J. A. Fejer (Southwest Center for Advanced Studies, Dallas) and W. Calvert. J. Geophys. Res., 69: 5049-62(Dec. 1, 1964).

The plasma resonances observed with the Alouette topside sounder satellite occur at the plasma frequency f_N, at multiples of the electron cyclotron frequency f_H, and at the frequency $f_T = (f_N^2 + f_H^2)^{\frac{1}{2}}$. These resonances can be attributed to electrostatic oscillations of the ionospheric electrons in the vicinity of the satellite. The frequencies f_N and f_H correspond to oscillations along the earth's magnetic field; the frequencies f_T and the harmonics of f_H, to oscillations across the field. The absence of responses corresponding to intermediate angles is accounted for by the greater group velocity of the pertinent electrostatic waves. These carry the energy away more rapidly and thus prevent long enduring plasma oscillations. The explanation presented, although it ignores the excitation mechanism, roughly accounts for the observed relative strengths of the resonances. (auth)

6599 THE EFFECTIVE EQUATOR FOR GEOMAGNETIC S_q VARIATIONS. Agodi Onwumechilli (Univ. of Ibadan, Nigeria). J. Geophys. Res., 69: 5063-73(Dec. 1, 1964).

Data from forty-two stations were analyzed for the epoch of September 1958 to determine the weights of the influences of the dip equator, the geographic equator, and

the dipole equator on quiet day geomagnetic variations. It was found that the dipole equator has no significant control on S_q variations. The effects of the geographic equator and the dip equator are equal far away from the equatorial electrojet, but close to the jet the influence of the dip equator is about twice that of the geographic equator. The weighting of the influences of the equators leads to the determination of the effective equator for S_q variations. The results suggest a mean normal equator half-way between the geographic and dip equators, and a two-to-one equator between the geographic and dip equators whose distance from the geographic equator is twice its distance from the dip equator. Plotting the daily range of $S_q(X)$ against latitude measured from the effective equator reduces the longitude effect which causes the scatter of points in such plots. On the tentative association of the boundary line between the northern and southern S_q current systems with the effective equator in a region uninfluenced by the equatorial electrojet, the boundary lines determined from the International Polar Year data (1932-1933) and the International Geophysical Year data (1957-1958) are then compared with the dip equator, the mean magnetic equator, the mean normal equator, and the two-to-one equator, respectively. The last two (obtained from this work) are found to agree better with the boundary lines than the first two. (auth)

6600 GEOMAGNETIC AND SOLAR DATA. J. Virginia Lincoln (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 69: 5087-8(Dec. 1, 1964).

Data on the principal magnetic storms of 1963 and early 1964 are presented. Data on geomagnetic activity in July 1964 are included, together with provisional sunspot numbers for July. (D.C.W.)

6601 PROBE AND GEIGER COUNTER ROCKET MEASUREMENTS OF A MINOR D-REGION EVENT. C. A. Accardo, L. G. Smith, and L. H. Weeks (Geophysics Corp. of America, Bedford, Mass.). J. Geophys. Res., 69: 5112-15(Dec. 1, 1964).

Electron density profiles were obtained during the ascent and descent of a rocket launched at Fort Churchill, Manitoba on July 14, 1963, using a d-c probe. Corpuscular radiation was also measured by a Geiger counter. The electron density profiles were enhanced in the D and lower E regions in comparison with a profile obtained six days later. Evidence for a variation in the source of ionization was noted. The electron intensity and energy (50 Mev) and the absorption corresponding to the data were determined. (D.C.W.)

6602 AVERAGE DIURNAL CHARACTERISTICS OF GEOMAGNETIC POWER SPECTRUMS IN THE PERIOD RANGE 4.5 TO 1000 SECONDS. Maurice J. Davidson (Columbia Univ., Palisades, New York). J. Geophys. Res., 69: 5116-19(Dec. 1, 1964).

The power density of rapid geomagnetic variations was studied as a function of period. The results confirm the approximately 6-db/octave slope reported elsewhere. (D.C.W.)

6603 HYDROMAGNETIC MOTIONS IN THE MAGNETOSPHERE. C. O. Hines (Univ. of Chicago). Space Sci. Rev., 3: 342-79(Oct. 1964).

Following a brief specification and historical review of hydromagnetic motions in the magnetosphere, the principles of the governing and limiting processes are surveyed. A formal proof of the well-known hydromagnetic theorem is included, and its interpretation in terms of frozen fields is discussed. Some consequences of its application to the magnetosphere are then described, and the value of equipotentials as a means of illuminating the discussion is established. Departures from the hydromagnetic approximation are then evaluated, and their resultant currents described. The general principles find application in a number of processes: rotation, high-latitude circulation in quiet and disturbed conditions, more widespread convection under continuous dynamo action, and irregular motion both of an unstable and of a forced type. All these are reviewed, and one emergent point is emphasized: that direct evidence for the hydromagnetic motions is lacking, but that it can and should be sought. (auth)

Low Temperature Physics

6604 ORIENTATION DEPENDENCE OF THE SUPERCONDUCTING BEHAVIOUR OF DEFORMED AND UNDEFORMED NIOBIUM SINGLE CRYSTALS. J. A. Catterall, I. Williams, and J. F. Duke (National Physical Lab., Teddington, Middx., Eng.). Brit. J. Appl. Phys., 15: 1369-75(Nov. 1964).

Current-carrying capacity and magnetization experiments were performed at 4.2°K on as-grown single crystals of niobium, and repeated after 10% deformation of the crystals by compression. The results are compared with those from the same material when cold-drawn to wire. Three critical magnetic fields are defined, H_1, H_2, and H_3. H_1 is the field corresponding to the peak in the (M, H) curves, H_2 is the field at which complete flux penetration occurs, and H_3 is the field where electric resistance is first observed. It is shown that H_1 and H_3 are orientation dependent and are raised by deformation, and that H_2 is not orientation dependent but is also raised by deformation. Anisotropies exist in the orientation dependence of the current-carrying capacity both before and after deformation of the crystals, and the effect of deformation on the current-carrying capacity is found to depend on the initial orientation of the crystal relative to the deformation axis. (auth)

6605 FLUX TRAPPING AND COMPRESSION IN SUPERCONDUCTING NIOBIUM–TIN TUBES. J. M. Corsan, G. W. Coles, and H. J. Goldsmid (General Electric Co. Ltd., Wembley, Middx., Eng.). Brit. J. Appl. Phys., 15: 1383-90(Nov. 1964).

Niobium-tin compacts were produced by pressing and sintering the powdered elements. Tube magnetization experiments on the material at 4.2°K in fields of up to 54 kOe yielded results that are consistent with the relation $J_c = a_c/(H + B_0)$, where J_c is the critical current density in a local magnetic field H and a_c and B_0 are constants. The highest critical current density to date was achieved by pressing at 30 ton in^{-2} and sintering at 975°C for 3 hours; the values of a_c and B_0 for niobium–tin prepared in this way are 4×10^6 kOe A cm^{-2} and 4 kOe respectively. The material is notable in that it seldom exhibits flux jumps; it is thought that this feature of its behavior is due to the presence of liquid helium in the interconnected pores. The absence of flux jumps indicates that the material can be used in the construction of mechanical flux compressors and the design of a flux compressor, which can yield 50 kOe in a working space of 1 cm diameter, is discussed. Preliminary experiments on flux compression up to a field of 23 kOe gave results in accordance with the theoretical predictions. (auth)

6606 MAGNETIC HYSTERESIS IN SUPERCONDUCTING THIN FILMS. Hollis L. Caswell (International Business Machines Corp., Yorktown Heights, N. Y.). J. Appl. Phys., 36: 80-4(Jan. 1965).

Tin films were deposited from the vapor at various substrate temperatures and their superconducting properties determined as a function of film structure. Magnetic hysteresis in the superconducting state to normal state phase transition of these films increased with increasing grain size. Hysteresis could be attributed solely to supercooling only in the smaller-grained films deposited at low substrate temperatures. For the larger-grained films, superheating was also observed. The hysteresis observed experimentally was in agreement with the predictions of the Ginzburg-Landau theory of superconductivity. (auth)

6607 A PROTECTED 100-kg SUPERCONDUCTING MAGNET. H. T. Coffey, J. K. Hulm, W. T. Reynolds, D. K. Fox, and R. E. Span (Westinghouse Electric Corp., Pittsburgh). J. Appl. Phys., 36: 128-36(Jan. 1965).

Superconducting wire made from heavily cold-worked ductile niobium–titanium wire shows much less degradation in solenoids than does the corresponding widely used niobium–zirconium alloy. The origin of this behavior is discussed in terms of flux jumping and the differences in metallurgical properties of the two alloy systems. The superior niobium-titanium alloy was used in the inner sections

of a 100,000-G solenoid which was driven normal repeatedly without damage. Details of design, construction, and operation of this solenoid are discussed with particular reference to critical rate of excitation under flux creep conditions. The normalization properties of the solenoid are analyzed in terms of the thermal propagation model, and the voltage rise and temperature maximum are estimated from this model. (auth)

6608 DEPENDENCE OF CURRENT DEGRADATION IN SUPERCONDUCTING SOLENOIDS ON FLUX PINNING ENERGY AND TEMPERATURE. R. W. Meyerhoff and B. H. Heise (Union Carbide Corp., Tonawanda, N. Y.). J. Appl. Phys., 36: 137-9(Jan. 1965).

The cause of the current degradation of superconducting solenoids, a subject of continuing interest, is elucidated further in this work. Two types of measurement are reported. Flux pinning energies and straight wire critical currents of 0.25-mm (10-mil) Nb–Zr wire are measured as a function of magnetic field. Solenoid critical currents are reported as a function of temperature for the same material. These measurements indicate that high pinning energy causes flux jumping which causes solenoid degradation. They further indicate that pinning energy can be weakened by increasing the temperature; therefore, flux jumping and coil degradation can be suppressed by increasing the temperature. (auth)

6609 INFLUENCE OF CONTROLLED ADDITIONS OF OXYGEN ON THE SUPERCONDUCTIVITY OF NIOBIUM. C. S. Tedmon, Jr., R. M. Rose, and J. Wulff (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 36: 164-7(Jan. 1965).

The critical current density vs applied transverse magnetic field was measured, for a superconducting niobium single crystal of controlled oxygen content, at successively higher levels of concentration; the oxygen content was increased in increments ranging from 2 to 50 ppm, under conditions of constant substructure, from an initial level of approximately 5 ppm to a final level of 360 ppm. The overall critical current density increased considerably on the addition of oxygen, and assuming γ to be independent of oxygen concentration, the upper critical field increases in accordance with the predictions of the GLAG theory for type II superconductivity. The critical current density above the upper critical field, which was ascribed to nucleation effects at defects or surfaces, was also very sensitive to the oxygen content. (auth)

6610 INFLUENCE OF SPIN PARAMAGNETISM OF SUPERCONDUCTIVITY. R. A. Kamper, R. S. Collier, and Y. Ohori (National Bureau of Standards, Boulder, Colo.). Phys. Rev., 137: A75-7(Jan. 4, 1965).

The Ginsburg–Landau equations are modified to include a magnetic permeability which varies with the order parameter ψ according to the relation: $\mu = \mu_0\psi^2 + \mu_n(1-\psi^2)$. The effect on the predicted behavior of a superconducting film in a tangential magnetic field is investigated theoretically. A new value is derived for the upper limit of the critical field for a bulk superconductor and a thin film. (auth)

6611 EFFECTS OF DISLOCATIONS ON THE SUPERCONDUCTING TRANSITION TEMPERATURE OF ALUMINUM AND ALUMINUM ALLOYS. W. C. H. Joiner (Rutgers State Univ., New Brunswick, N. J.). Phys. Rev., 137: A112-18(Jan. 4, 1965).

The effect of dislocations on the superconducting transition temperature T_c and residual resistivity ratio ρ of pure Al and Al containing dilute concentrations of chemical impurities was studied. Dislocations were produced in the pure metal by cold-working, quenching, deformation in uniaxial tension, and fatigue. Each of these methods of deformation produces a known kind of dislocation and dislocation arrangement. In every case in which an increase in ρ was observed, there was a corresponding decrease in transition temperature ΔT_c, from the pure-metal value. Annealing of the cold-worked metal in the proper temperature range produced a decreasing ρ and a decreasing ΔT_c. For every method of deformation and at every stage of annealing, the correlation between electron scattering and transition temperature (ΔT_c, versus ρ) was the same as with low-concentration electropositive impurities. For the deformation of impure Al, it was found that dislocations plus Zn (electropositive) impurities showed a correlation between ρ and ΔT_c which was the same as if the total scattering were due to Zn impurities. For dislocations plus Ge or Si (electronegative) impurities, ΔT_c is greater than one would obtain using the measured ρ and the curves for Ge or Si alone. The latter results are discussed on the basis of the work of Markowitz and Kadanoff, and it is shown that the portion of ΔT_c which can be associated with changes in the anisotropy of the energy gap correlates with changes in electron mean free path in the manner expected. (auth)

6612 SUPERCONDUCTIVITY IN BINARY ALLOY SYSTEMS OF THE RARE EARTHS AND OF THORIUM WITH Pt-GROUP METALS. T. H. Geballe, B. T. Matthias, V. B. Compton, E. Corenzwit, G. W. Hull, Jr., and L. D. Longinotti (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 137: A119-27(Jan. 4, 1965).

Superconductivity was observed in many binary systems composed of transition metals having nearly empty and nearly filled d shells. With the exception of the Sc–Pt and Ce–Rh systems, all contain at least one superconducting phase and frequently more. By comparing the transition temperatures of analogous compounds, it is inferred that pure Rh should become superconducting above 10 mdeg and pure Pt at a considerably lower temperature. (auth)

6613 SUPERCONDUCTIVITY OF α–TITANIUM SOLID SOLUTIONS WITH VANADIUM, NIOBIUM, AND TANTALUM. Ch. J. Raub (Univ. of California, San Diego, La Jolla) and U. Zwicker. Phys. Rev., 137: A142-3(Jan. 4, 1965).

It was found that the hcp solid solutions of V, Nb, and Ta in α–Ti show a nearly linear increase in T_c. There is no difference in the effect of V, Nb, or Ta. (auth)

6614 TIME- AND POSITION-DEPENDENT SUPERCONDUCTIVITY. R. H. Parmenter (RCA Labs., Princeton, N. J.). Phys. Rev., 137: A161-3(Jan. 4, 1965).

Anderson's time-dependent generalization of the BCS theory of superconductivity and Parmenter's position-dependent generalization were successfully combined. The resultant formalism is capable of treating a number of previously intractable problems. The derived boundary conditions are consistent with, but more general than the boundary conditions previously assumed by Ginsburg and Landau and by Parmenter. The formalism is strikingly analogous to "micromagnetics," the continuum theory of ferromagnetism in solids. (auth)

6615 TEMPERATURE DEPENDENCE OF THE SUPERCONDUCTIVITY ENERGY GAP. Richard A. Ferrell (Univ. of California, Berkeley). Z. Physik, 182: 1-3(1964).

It is noted that the Taylor's series expansion at the transition temperature expresses the temperature dependence of the energy gap of a superconductor to an accuracy of better than one-half of a percent for the upper half of the superconducting temperature range, when only the first three terms of the series are retained. Because of the smallness of the third term an equally good expression over the same temperature range is the following two term formula: $[\Delta(t)/\Delta(0)]^2 \approx 3.016(1-t)-2.400(1-t)^2$, where $\Delta(t)$ is the energy gap and t the reduced temperature. (auth)

6616 CRYOGENIC AND SUPERCONDUCTING DEVICES. Edmund E. Callaghan (Lewis Research Center, Cleveland). p.105-11 of "NASA SP-5015."

The principles of cryogenic conductivity and superconductivity are discussed along with application of these principles. (J.R.D.)

6617 THE SUPERCONDUCTING ENERGY GAP OF LEAD ABOVE H_c. Y. Goldstein (RCA Labs., Princeton, N. J.). 11p. (CONF-651-16)

From 9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug.-Sept. 1964.

The existence of surface superconductivity in pure lead with parallel magnetic fields, $H_{||}$, above the thermodynamic critical field, H_c, was observed with tunneling measure-

ments. While the energy gap in the bulk is zero, at the surface it attains its full value up to $H_{||} = 1.22\ H_c$ (at 1.4°K). The tunneling conductance shows contributions both from superconducting and normal regions. The results are interpreted by assuming the normal region contributing to tunneling being located in the bulk below the surface. The data fit fairly well a simplified model assuming contributions to tunneling from regions within a tunneling mean free path, ℓ, of the surface and the energy gap falling off as $\exp[-\frac{1}{2}(x - x_0)^2/\xi^2]$ with the distance, x, from the surface. Values for H_{c3}/H_c over the temperature range of 1.4–4.2°K are also presented. (auth)

6618 ENERGY LOSS BY MOVEMENT OF MAGNETIC FLUX THROUGH BULK SUPERCONDUCTORS. S. L. Wipf (Westinghouse Electric Corp., Pittsburgh). 26p. (CONF-452-69)

From American Physical Society, Washington, D. C., Apr. 1964.

The energy losses in rotating a superconductor in a uniform magnetic field were measured for single crystals of pure V, Ta, and Nb. The losses are proportional to the volume of the specimen and, at the same relative field $h = H/H_{c_2}$ roughly proportional to $(1 - (T/T_c)^2)^2$. A strong dependence on the direction of the magnetic field with respect to the crystal axis is indicative of dislocations being responsible for the loss mechanism. An interpretation is given in terms of flux pinning. (auth)

Neutron Physics

6619 (AWRE-O-77/64) NEUTRON CROSS SECTIONS OF NATURAL TITANIUM IN THE ENERGY RANGE 0.001 ev TO 18 Mev—INCORPORATION OF UNITED NUCLEAR CORPORATION DATA IN THE UKAEA NUCLEAR DATA LIBRARY. Susan M. Miller and K. Parker (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Oct. 1964. 54p. Dep.(mn).

UNC neutron cross section data for natural titanium have been modified as necessary and incorporated in the UKAEA Nuclear Data Library. Energy and angular distributions of secondary neutrons from elastic scattering and the (n,n′) and (n,2n) processes are given so that the data are complete for the purposes of neutronics calculations. The appropriate nuclide identification number is 190. (auth)

6620 (NAA-SR-Memo-8662) AGE OF FISSION NEUTRONS TO INDIUM RESONANCE ENERGY IN WATER. PART II. THEORY. H. Alter (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 16, 1964. Contract AT(11-1)-Gen-8. 152p. Dep.(mn); $5.00(cy), 3(mn) OTS.

The Monte Carlo code TYCHE-III was used to calculate with a high degree of convergence the second, fourth, and sixth spatial moments of the slowing down density distribution at the indium resonance energy, for neutrons originating from a fission source at a point in an infinitely extended water moderator. The effects of both inelastic scattering and anisotropy of elastic scattering in oxygen were included. The calculations were performed for several sets of data on oxygen cross sections and angular distributions. Finally the effects on the neutron age and higher spatial moments of various fission spectra are reported. These calculations were compared with the moments of experimentally-measured distributions of neutron flux at the indium resonance energy, after applying a suitable correction from the slowing down moments. (auth)

6621 A NOTE ON THE AVERAGE NUMBER OF COLLISIONS UNDERGONE BY NEUTRONS IN A LARGE LETHARGY INTERVAL. C. Wilkins (Univ. of Auckland, N. Z.). Australian J. Appl. Sci., 15: 75-83(June 1964).

For a distributed source S(u) in a non-absorbing infinite homogeneous system containing one heavy species, the following approximation is given for the integrated collision density: $N(u) = [\int_0^u dt/f_1(t) + f_2(u)/2\ \{f_1(u)\}^2] \int_0^u S(u_s)du_s - \int_0^u S(u_p) \int_0^{u_p} dt/f_1(t)\ du_p$ where $f_k(u)$ is the (varying) average k-th power of the lethargy gain. In deriving this expression, it is assumed that at the higher (epithermal) lethargies, the scattering kernel is that of Hurwitz, Nelkin, and Habetler while for the lower lethargies, one due to Weinberg and Wigner is assumed. Corresponding assumptions are made about the order of magnitude of the disturbances due to anisotropy. The range of applicability of this approximation is determined by these assumptions. (auth)

6622 DEPENDENCE OF EFFECTIVE RESONANCE INTEGRALS ON MODERATOR SLOWING DOWN PROPERTIES. M. H. McKay (Univ. of New South Wales, Kensington, Australia). J. Nucl. Sci. Technol. (Tokyo), 1: 279-83 (Nov. 1964).

A modified effective resonance integral is defined in such a way as to fit the exponential form of the resonance escape probability. Application of a generalized "intermediate-resonance" approximation to this modified effective resonance integral shows a dependence on the slowing-down properties of the moderating nuclei in good agreement with exact calculations. (auth)

6623 SOLVING THE TRANSPORT EQUATION IN HETEROGENEOUS MEDIA USING FIRST-FLIGHT GREEN'S FUNCTIONS FOR HOMOGENEOUS MEDIA. John P. Church (E. I. du Pont de Nemours & Co., Aiken, S. C.). Nucl. Sci. Eng., 21: 49-61(Jan. 1965).

The integral neutron transport equation is solved for the space-dependent monoenergetic neutron density in a unit cell. By using step functions to represent the spatial dependence of the collision probabilities, the integro-differential transport equation is rearranged, such that the left-hand side contains only the leakage term and the term describing the total collision probability for the homogeneous medium of one region, k′, of the original problem. The Green's function technique is then used to convert the integro-differential equation to an integral equation. Thus, although the resulting equation may be applied to a heterogeneous cell, the kernel of the equation depends only on the total collision probability in the particular region k′. Numerical results are presented for a two-region unit cell in slab geometry and are compared with the results of DSN, P_N, double-P_N and variational calculations. For unit cells that are of the order of two mean free paths or less in thickness, the zero-order spherical harmonic approximation for this method yields results comparable to very high order DSN, P_N, and double-P_N calculations. Further, once the Green's function is computed, additional cell calculations can be performed with relatively little additional effort. (auth)

6624 TRANSPORT EFFECTS IN DIFFUSION THEORY. G. C. Pomraning (General Electric Co., Pleasanton, Calif.). Nucl. Sci. Eng., 21: 62-78(Jan. 1965).

A diffusion theory for the asymptotic transport scalar flux is derived from the monoenergetic transport equation in slab geometry. By allowing the scalar flux to be discontinuous at a material property and/or an external-source discontinuity, the theory can predict exact asymptotic transport-theory behavior for two standard half-space problems. A supplementary diffusion-like theory is developed to treat the non-asymptotic flux. The total (asymptotic plus non-asymptotic) formalism yields a continuous scalar flux distribution and gives exact transport-theory leakage from a half-space with a spatially-constant source. Numerical comparisons indicate that the proposed theory is significantly more accurate than classical (P_1) diffusion theory. The complexity of both the asymptotic and non-asymptotic formalisms is comparable with that of the P_1 method. Finally, the entire formalism is generalized to three dimensions in rectilinear and curvilinear–coordinate systems. (auth)

6625 MODIFICATION TO PRESCRIPTION FOR ($k\beta/l$) PULSING. Lawrence Ruby (Univ. of California, Berkeley). Nucl. Sci. Eng., 21: 115(Jan. 1965).

A modification of the Garelis prescription for production of neutron pulses by deflection of an accelerator beam from the target is outlined. (D.C.W.)

6626 FIRST-COLLISION PROBABILITY OF AN INFINITE RECTANGULAR CYLINDER. N. J. McCormick

(Univ. of Michigan, Ann Arbor). Nucl. Sci. Eng., 21: 120 (Jan. 1965).

The first-collision probability for an infinite cylinder of rectangular cross section with side lengths a_1 and a_2 was evaluated for $a_1 = a_2 = a$, where a is the diameter. The differences in first-collision probabilities between the square cylinder and various approximations were studied. (D.C.W.)

6627 MODERATOR SCATTERING AND FLUX DEPRESSION NEAR RESONANCES. Paul F. Gast (Argonne National Lab., Ill.). Nucl. Sci. Eng., 21: 121(Jan. 1965).

The first-order solution for the flux near an intermediate-width resonance was previously obtained in terms of a width parameter and a second-order flux obtained by iteration. The second-order flux is calculated, obtaining the correct reduction in flux on the low-energy side of the resonance by treatment of scattering by the moderator in the same approximation as heavy-element scattering. (D.C.W.)

6628 AN INVESTIGATION OF SLOWING-DOWN PARAMETERS FOR NEUTRONS IN LIQUID HYDROGEN. Victor Henry Bouquet, Jr. (Univ. of North Carolina, Raleigh). 80p. (CONF-446-77)

From American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

Slowing-down parameters were investigated theoretically at very low energies. IBM 650 and 1410 computers were used to obtain energy transfer cross sections, logarithmic energy decrements, and average cosines of the scattering angle. The basis for all calculations at low energy was Sarma's scattering model which assumed the liquid hydrogen molecules to behave as molecules of a perfect gas. Values for the Fermi age for several mixtures of liquid hydrogen were calculated. The age from fission to thermal energy cutoff for an equilibrium mixture of liquid hydrogen at 20°K was found to be 126 cm^2. For this mixture the diffusion coefficient and the diffusion length for a Maxwellian distribution of neutrons were found to be 4.1 cm and 10.3 cm respectively. (auth)

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Refer also to abstracts 5869, 6225, and 6422.

6629 (AD-600710) THE DYNAMIC COLLECTIVE THEORY OF ODD A NUCLEI. Report 381. Michael Danos (National Bureau of Standards, Washington, D. C.), Walter Greiner, and C. Byron Kohr (Maryland. Univ., College Park). May 1964. 48p.

The unified model and the collective giant dipole resonance model are unified. The resulting energy spectrum and the transition probabilities are derived. A new approximate selection rule involving the symmetry of the gamma-vibrations is established. It is verified that the main observable features in the photon absorption cross section are not influenced by the odd particle, despite the considerably richer spectrum of states as compared to even-even nuclei. (auth)

6630 (AD-601793) THE (n,2n) REACTION ON DEUTERIUM. Dale R. Koehler (Army Missile Command, Redstone Arsenal, Ala.). Apr. 22, 1964. 46p. (RR-TR-64-4) $1.25 (OTS).

The D(n,p)2n reaction is treated in a direct interaction framework wherein phenomenological nucleon-nucleon potentials are used to describe the perturbation interactions. Tensor forces as well as central forces are included and final state interactions among the particles is considered. The final state is pictured as a continuum deuteron plus free neutron or as a continuum dineutron plus free proton. To the extent that this picture is accurate, it is found that the main contributions to the cross section are supplied by the doublet to doublet transitions. The calculations furthermore suggest a best choice for the triplet even parity central potential. A comparison with experimental results at 14.4 Mev is presented. (auth)

6631 (IDO-17025) COMPARISON OF THE PROMPT FISSION GAMMA SPECTRUM OF U-233 INDUCED BY THERMAL NEUTRONS AND BY 1.8 ev RESONANCE NEUTRONS. M. S. Moore and R. R. Spencer (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Oct. 1964. Contract AT(10-1)-205. 11p.

With the use of a single-crystal NaI(Tl) gamma-ray spectrometer, the spectrum of prompt fission gamma rays of ^{233}U was investigated. A comparison was made of the gamma spectrum in coincidence with fragments of fission induced by near-thermal neutrons (0.06 ev) and by neutrons of 1.8 ev, corresponding to the energy of the first large resonance in ^{233}U. Within the limits of accuracy of the measurement, the gamma spectra obtained at the two neutron energies are identical. (auth)

6632 (JINR-P-1795) OB ODNOM METODE VYCHISLENIYA SECHENII V OPTICHESKOI MODELI. (On a Method for Calculating the Cross Section in the Optical Model). V. V. Babnkov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Reactions). 1964. 6p. Dep.(mn).

A method is suggested for calculating cross sections using the optical model of nuclear reactions. It proves helpful in practical applications. (auth)

6633 (JINR-P-1796) VZAIMODEISTVIE CHASTITS S VESHCHESTVOM PRI OCHEN BYSOKIKH ENERGIYAKH. (Particle Interaction with Matter at Superhigh Energies). V. S. Barashenkov and S. M. Eliseev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 7p. Dep.(mn).

It is shown that calculations of the particle interaction with nuclei, made by the intranuclear cascade method, agree with experiment up to energies of ≈1000 Bev. (auth)

6634 (JINR-P-1800) IZUCHENIE VTORICHIYKH REAKTSII PRI BOMBARDIROVKE MEDI PROTONAMI S ENERGIEI 140-660 Mev. (A Study of Secondary Reactions in Bombarding Copper by 140-660 Mev Protons). V. N. Mekhedov, V. N. Rybakov, N. S. Mal'tseva, S. P. Makarov, and Ch'uan-p'eng Wang (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1964. 21p. Dep.(mn).

Using radiochemical methods, new data were obtained on the production cross sections of Ga, Ge, As, Se, and ^{67}Cu isotopes when bombarding natural Cu by 140- to 660-Mev protons. (auth)

6635 (JINR-P-1830) METOD SAMOSOGLASOVANNOGO POLYA I KOLLEKTIVNYE VOZBUZHDENIYA MODEL'NYKH FERMI SISTEM. (A Self-Consistent Field Method and Collective Excitations of Model Fermi-Systems). E. Chervonko (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 11p. Dep.(mn).

The collective excitations of model Fermi systems are considered, for which the linearized Hamiltonian requires one Hartree-Fock transformation and a special Bogolubov transformation for the diagonalization. The vacuum state of the quasi-particles diagonalizing the linearized Hamiltonian serves as a starting point for the Bogolubov self-consistent field method. For the systems under consideration the equations of the method have a simple solution, and are always able to obtain the dispersion equations in the compact form. The case when the particles are paired only in the S-state is considered in more detail. Then the spurious state is eliminated naturally. The results may be applicable in the theory of the deformed nucleus when the residual interaction consists of pairing and of any number of the even zero-projection multipoles. (auth)

6636 (NASA-TR-R-218) POLARIZATION OF PROTONS FROM (d,p) REACTIONS AT 21 Mev. Edmund T. Boschitz and John S. Vincent (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Dec. 1964. 20p. $1.00(OTS).

The proton polarization in deuteron stripping has been measured for the target nuclei beryllium (^{9}Be), boron (^{10}B), carbon (^{12}C), silicon (^{28}Si), and calcium (^{40}Ca) between 20 and 120°. The results are generally consistent with other polarization measurements at 13.6 and 15.0 Mev, but they differ markedly from polarization data at lower deuteron energies. A comparison of ground and

first excited-state polarizations in ^{9}Be suggests that the total angular momentum j_n for the captured neutron in both states is the same, that is, $j_n = 3/2$. For the ^{12}C reaction, a comparison of the proton polarization with the cross section asymmetry, induced by 22-Mev vector-polarized deuterons, shows a linear relation that is compared with the Distorted Wave Born Approximation (DWBA) predictions. The differential cross sections for deuteron stripping from ^{9}Be, ^{12}C, and ^{46}Ca have also been measured. (auth)

6637 (NOLTR-64-46) EXCITED LEVELS OF N^{15} AND O^{15}. A. E. Evans (Naval Ordnance Lab., White Oak, Silver Spring, Md.). Mar. 9, 1964. 15p. (AD-601965). $0.50(OTS).

The theory of 1p-shell energy levels is reviewed, with particular emphasis on calculations for ^{15}N and ^{15}O. The effect of the relative strengths of space and spin-exchange forces and the spin-orbit force is discussed. Experimental data on the level structures of ^{15}N and ^{15}O are compared with each other and with theory. Particular emphasis is placed upon spin and parity assignments for the first eleven levels in ^{15}O. Gaps and discrepancies are pointed out and suggestions made as to means for their resolution. (auth)

6638 (NP-14541) MÖSSBAUER SCATTERING STUDIES WITH THE ISOTOPES OS^{186}, OS^{188}, EU^{153} AND PR^{141} (thesis). Rollin John Morrison (Illinois, Univ., Urbana). Sept. 1964. 77p.

The observation of sizable Mössbauer effects with gamma rays of energies up to 155 kev, is described. In order to observe significant effects for transitions with large recoil energies, and therefore small recoilless fractions, the experiments were performed with a scattering geometry. Some theoretical aspects of Mössbauer scattering are discussed. Calculations of the recoilless and nonrecoilless scattered intensities for single line Lorentzian distributions are presented. The scattered intensities are expressed in terms of a scattering function which contains the parameters of the scatterer. The scattering function was evaluated for a wide range of values of the recoilless fraction, electronic absorption, thickness, and line width of the scatterer. The attractiveness and general applicability of the scattering method are demonstrated by the experimental results. The effects observed for the various sources and scatterers are given in the table below. These measurements were made with source and scatterer temperatures below 35°K.

Isotope	E, kev	Source	Scatterer	Effect
Eu^{153}	103	Sm_2O_3	Eu_2O_3	30%
Eu^{153}	103	SmF_3	Eu_2O_3	18%
Os^{186}	137	Re metal	Os metal	9.7%
Pr^{141}	145	CeO_2	Pr_6O_{11}	4%
Pr^{141}	145	CeF_3	Pr_6O_{11}	3%
Os^{186}	155	Re metal	Os metal	6.5%

The products of the source and scatterer recoilless fractions were determined from the scattered intensities with the aid of the calculated scattering function. With the assumption that the source and scatterer Debye temperatures θ_D were equal, values $\theta_D = (312 \pm 7)$°K and $\theta_D = (322 \pm 7)$°K were determined from the scattered intensities for the Os^{186} and Os^{188} measurements. Experiments were performed with higher source and scatterer temperatures. From these measurements it was found that the effective Debye temperature increases with temperature and with the magnitude of the recoil energy. Recoilless fractions and Debye temperatures were calculated for all of the measurements. Ferrimagnetic europium iron garnet was also used as a scatterer for the 103 kev transition of Eu^{153}. From the magnetic hyperfine pattern observed, the ratio of the excited state and ground state g factors was determined. Using a previously measured value for the ground state magnetic moment, the value $\mu^* = (1.9 \pm 0.2)$ n m was found for the magnetic moment of the excited state. (auth)

6639 (TID-21387) THE SHAPE OF THE INTENSE POSITRON SPECTRUM OF SODIUM-22 (thesis). William Henry Brantley (Vanderbilt Univ., Nashville. Graduate School). Aug. 1963. Contract AT(40-1)-1327. 33p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Backscattering off the end of the source rod is ruled out as the reason for the excess of low energy electrons. There is the possibility that, since the same sources were used for these measurements as for some of the previous work, the deviation from a statistical shape for the positron spectrum of ^{22}Na in this case is due to these particular sources, although this seems unlikely. It is certainly not from effects of the source backings. The difference in the source holder arrangement in the spectrometers used also suggests that scattering in the near vicinity of the source is not responsible for the deviations. The deviation in the ^{93}Zr positron spectrum has been previously explained in terms of second-order effects such as finite size effects. These same terms are expected to explain the ^{22}Na spectrum. It has been shown that thick source backings (0.14 mg/cm^2 and greater) definitely distort the positron spectrum at low energies. The energy at which backscattering distortions with 0.18 mg/cm^2 thick foils begin may be some function of the endpoint of the beta spectrum. This could be checked more thoroughly. Data on the high-energy spectra of ^{90}Y ($E_\beta = 2.26$ Mev) and ^{32}P ($E_\beta = 1.71$ Mev) indicate that any backscattering distortion is below 150 to 200 kev for a 0.18 mg/cm^2 thick foil. (auth)

6640 NUCLEON POLARIZATION EFFECT ON SPECTRUM OF μ-MESONIC HYDROGEN ATOM. Hideki Yukawa and Shigeru Matsuo. Bull. Inst. Chem. Res., Kyoto Univ., 42: 422-4(Sept. 1964).

An investigation was made on whether or not the nucleon polarization effect may be detected from the $2p \rightarrow 1s$ transition spectrum of the μ-mesonic hydrogen atom. Although final results were not obtained, an outline of calculations obtained thus far is given. The pion cloud polarization effect of the nucleon in the μ-mesonic hydrogen atom is two or three orders of magnitude larger than the natural line breadth of the 2p state. Thus, a possibility of detecting this effect in principle is observed. (P.C.H.)

6641 PROTON-NEUTRON RESIDUAL INTERACTIONS AND THE COUPLING RULES IN ODD-ODD DEFORMED NUCLEI. Alceu G. de Pinho Filho and Jean Picard (Centre d'Etudes Nucleaires, Saclay, France). Compt. Rend., 259: 2372-5(Oct. 12, 1964). (In French)

The expectations of the Gallagher–Moszkowski coupling rules were compared with the spacing of the doublet from the residual central interaction between the unpaired proton and neutron. (tr-auth)

6642 SECONDARY QUANTIZATION CONCEPT FOR QUADRUPOLE OSCILLATIONS OF AXIAL NUCLEI. D. P. Leper. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 3-13(1963). (In Russian)

An attempt was made to develop the second quantization method for deformed axial nuclei. The method does not require concrete data on the type of operators or wave functions and can be reduced to production and annihilation operators. Utilization of the S coordinate system, which does not coincide with the proper nuclear S′ system, is another advantage. The formulas are developed in a sequence that finds the expression for classical, kinetic energy in the proper system, followed by kinetic energy quantization expressed by S-system variables. The rotational part of the kinetic energy is described by a projection of moments on the axis of the S system. The final equation is found by nonadiabatic reduction of the production operator, and cancellation of the hamiltonian. The secondary quantization concept can be used in calculating electromagnetic transitions and in other cases with axial nuclear quadrupole oscillations. (R.V.J.)

6643 THE APPLICATION OF RESONANCE γ-QUANTUM SCATTERING IN DETERMINING LIFETIMES OF SECONDARY EXCITATION STATES OF NUCLEI. A. F. Akkerman, E. Ya. Vilkoviskii, and V. N. Chekanov. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 19-30(1963). (In Russian)

The resonance scattering method may be used for measuring lifetimes of second excitations when they are close to or exceed the lifetime of the first excitation level.

The use of a coincidence scheme in investigations of resonance scattering cross sections as functions of the angle between γ cascades at various source densities improves the accuracy of lifetimes. The advantages of the resonance scattering method, as compared to Coulomb excitation, are limited to nuclei with small A whose second levels are high and multiple cross sections are very small. (R.V.J.)

6644 SOME SHORT-LIVED ISOTOPES OF CERIUM AND PRASEODYMIUM. D. C. Hoffman and W. R. Daniels (Los Alamos Scientific Lab., N. Mex.). J. Inorg. Nucl. Chem., 26: 1769-93(Nov. 1964). (LADC-3882)

The following β-decay chains of cerium and praseodymium were identified in the fission products of ^{235}U: ^{147}Ce(65 ± 6 sec)-^{147}Pr(12.0 ± 0.5 min) and ^{148}Ce(43 ± 10 sec)-^{148}Pr(1.98 ± 0.10 min). The cerium half lives were determined by measuring the relative amounts of the praseodymium daughter activities in samples milked from fission product cerium at suitable intervals. The praseodymium half lives were obtained by direct observation of the decay of the milked samples. Studies of the radiations of ^{147}Pr and ^{148}Pr with β- and γ-scintillation spectrometers indicated total β-decay energies of 2.7 ± 0.2 Mev and 4.5 ± 0.4 Mev, respectively. A partial decay scheme for ^{147}Pr is proposed. The mass assignments of 5.98-hr ^{145}Pr and the 12-min ^{147}Pr were substantiated by (γ,p) reactions on enriched ^{146}Nd and ^{148}Nd. Similar irradiations of ^{150}Nd produced some evidence for an ~2.3 min activity attributable to ^{149}Pr. (auth)

6645 HALF LIVES OF ^{143}Pm AND ^{144}Pm. L. R. Bunney and E. M. Scadden (Naval Radiological Defense Lab., San Francisco). J. Inorg. Nucl. Chem., 26: 1795-1800(Nov. 1964).

The half life of ^{143}Pm was determined as 267 ± 15 days and of ^{144}Pm as 349 ± 16 days. The ^{143}Pm was produced by an (α,2n) reaction on ^{141}Pr and ^{144}Pm was produced by a (p,n) reaction on enriched ^{144}Nd (95.7%). Irradiation conditions were selected which would minimize the formation of other promethium isotopes. The decay of ^{143}Pm was followed on γ counters and that of ^{144}Pm on γ and β counters. The energies of the γ rays emitted during the decay of these isotopes were determined from γ pulse-height-distribution curves and were in agreement with the published data. (auth)

6646 DEPENDENCE ON MAGNETIC FIELD OF POLARIZATION OF RADIATION FROM ELECTRON-HELIUM COLLISION. R. H. Hughes and L. D. Weaver (Univ. of Arkansas, Fayetteville). J. Opt. Soc. Am., 54: 1493-4(Dec. 1964).

Measurements were made of the polarization of $^3D \rightarrow {}^3P$ and $^1D \rightarrow {}^1P$ radiation induced by electron impact on helium as a function of the magnetic field. The polarization for $4^1D \rightarrow 2^1P$ radiation and the $4^3D \rightarrow 2^3P$ radiation decreased as the field increased, however data on the $4^3D \rightarrow 2^3P$ radiation were inconclusive. (M.C.G.)

6647 EXCITATION OF THE 2p LEVEL IN LITHIUM BY ELECTRON IMPACT. R. H. Hughes and C. G. Hendrickson (Univ. of Arkansas, Fayetteville). J. Opt. Soc. Am., 54: 1494(Dec. 1964).

The excitation function for the $2p \rightarrow 2s$ (λ 6708 Å) line in the first spectrum of lithium was obtained by observing this radiation from the interaction region formed by a lithium atomic beam and a crossed electron beam. Cross sections were estimated for populating np levels in all alkali metals by electron impact. (M.C.G.)

6648 POSSIBLE G-PARITY NONCONSERVATION IN MUON CAPTURE REACTIONS. Masato Morita and Reiko Morita (Kyoto Univ.). J. Phys. Soc. Japan, 19: 1759-64 (Oct. 1964).

A theory of muon capture is outlined, including induced effects from non-conservation of G-parity. Formulas for the partial transition rate are given for each forbiddenness. (D.C.W.)

6649 GENERALIZED SENIORITY SCHEME. Akito Arima and Hideo Kawarada (Tokyo Univ.). J. Phys. Soc. Japan, 19: 1768-82(Oct. 1964).

The seniority scheme introduced by Racah is generalized to the case of degenerate levels. Formulas for the pure configuration j^n are modified in order to calculate matrix elements in this generalized seniority scheme. The most interesting result is that the diagonal matrix element of two-body operators between the states with the same seniority v can be expressed in terms of the matrix elements in the v-particle system. This result holds in the case of the pure configuration. (auth)

6650 REPRESENTATIONS OF THE SYMMETRIC GROUP AND THE FRACTIONAL PARENTAGE COEFFICIENTS. Hisashi Horie (Tokyo Inst. of Tech.). J. Phys. Soc. Japan, 19: 1783-99(Oct. 1964).

The fractional parentage coefficients are treated by using the Young operator of the symmetric group, and general expressions for the coefficients are obtained. From these expressions the fractional parentage coefficients which separate any numbers of particles from the others can be evaluated for pure or mixed configurations. In order to calculate the fractional parentage coefficients which split off more than one particle, non-standard representations of the symmetric group are used. The representations are the outer products of two representations of the symmetric group, and the transformation coefficients with the standard representations are calculated. (auth)

6651 FISSION OF URANIUM-238 INDUCED BY 55 Mev PROTONS. Shoji Shirato, Shinzou Kubota, Hisao Takahashi, Tadayoshi Doke, Iwao Ogawa, Masahiro Tsukuda, and Eizo Tajima (St. Paul's Univ., Tokyo). J. Phys. Soc. Japan, 19: 1809-17(Oct. 1964).

The distributions of fragment kinetic energies and masses in the fission of ^{238}U were measured in various directions with respect to the beam, using a back-to-back arrangement of surface-barrier detectors. The energy distribution showed a single broad peak with a slight shoulder on the high energy side, indicating a marked growth of symmetric fission. The most probable value of the total fragment kinetic energy was observed to be 156 ± 5 Mev. The initial total kinetic energy before neutron emission was estimated from the value to be about 161 Mev. The mass distribution obtained in the transverse direction was in fair agreement with the radiochemical result. By making a fine comparison between these results, an attempt was made to obtain some information about neutron yields from individual fragments. The mass distribution in the backward direction was almost the same in shape as in the transverse direction, when corrected for the projectile momentum. Furthermore, the observed angular distribution of the composite fragments was less anisotropic than expected from the Halpern-Strutinski theory. (auth)

6652 ALPHA EMITTING REACTIONS ON Be^9, B^{10}, AND B^{11} INDUCED BY PROTONS, DEUTERONS AND ALPHA-PARTICLES. Takuji Yanabu, Sukeaki Yamashita, Shigeru Kakigi, Dai-Ca Nguyen, Kiyohiko Takimoto, Yasumasa Yamada, and Kouya Ogino (Kyoto Univ.). J. Phys. Soc. Japan, 19: 1818-23(Oct. 1964).

The angular distributions of alpha particles from the reactions ^{9}Be(p,α)^{6}Li (ground state), ^{9}Be(d,α)^{7}Li (ground, first and second excited states), ^{10}B(p,α)^{7}Be (ground state), ^{10}B(d,α)^{8}Be (ground state), ^{11}B(p,α)^{8}Be (ground state) and ^{11}B(d,α)^{9}Be (ground and second excited states) and from the elastic and inelastic (second excited state) scattering of alpha particles by ^{9}Be were obtained. The angular distribution of deuterons from the reaction ^{9}Be(p,d)^{8}Be (ground state) was also measured. The energies of the incident beams were about 7 Mev for protons, 14 Mev for deuterons, and 28 Mev for alpha particles. The results, except for ^{10}B(p,α)^{7}Be and ^{11}B(p,α)^{8}Be, show forward and/or backward rises and may be interpreted by direct interactions. The integrated cross sections of the reactions (p,α) and (d,α) on ^{9}Be are larger than those on ^{10}B and ^{11}B. (auth)

6653 DECAY OF Eu^{159}. Takeki Iwashita, Takashi Inamura, and Seizaburo Kageyama (Tokyo Univ.). J. Phys. Soc. Japan, 19: 1995-6(Oct. 1964).

The energy level scheme of ^{159}Gd was investigated by measuring the single gamma spectrum and gamma-gamma

coincidence spectrum following the decay of 20-min ^{159}Eu. An energy level scheme for ^{159}Gd is proposed. (D.C.W.)

6654 STUDY OF THE MÖSSBAUER EFFECT WITH THE 14.4-kev γ RAYS OF ^{57}Fe. Y. T. Hsue, G. M. Ma, Y. F. Wang, and P. C. Hsieh. K'o Hsueh T'ung Pao, No. 7, 617-19(1964). (In Chinese)

The Mössbauer effect in the emission or absorption of γ radiation involving 20 recently studied nuclei is reviewed. The discovery of the recoilless resonance absorption of the 14.4-kev γ radiation of ^{57}Fe is considered. The Mössbauer effect of the 14.4-kev of ^{57}Fe is used to test the infrared shift, the secondary Doppler effect, and several other physical properties of Fe in alloys and compounds. A cyclone type accelerator was used to produce 12-Mev α particles, which were allowed to strike a high-purity Fe target. After 1000 μamp hours, 1 μC of ^{57}Co was produced from ^{56}Fe by the (α,n) reaction. By means of a special technique, ^{57}Co was precipitated on a stainless steel plate, which after heating to 900°C in an H_2 atmosphere, gave a good γ source. The γ spectrum of this source, measured with an instrument provided with an NaI crystal, exhibited the 14.4-kev γ peak. Placing an 8.6 mg/cm^2 stainless steel foil between the source and the crystal resulted in a 27.5% increase of the peak. The resonance absorption was determined in a third series of experiments. On the basis of the resonance absorption measurements, the speed spectrum corresponding to the Doppler speed related to ^{57}Fe in the 14.4 kev range, was found to be 0.2 mm/sec. (TTT)

6655 THE DETERMINATION OF GAMMA-RAY EMITTING NUCLIDE ACTIVITY IN RADIONUCLIDE PRODUCTION. K. Wagner, H. Stephan, and H. Poser (Zentralinstitut fur Kernforschung, Rossendorf, Ger.). Kernenergie, 7: 714-15(Oct. 1964). (In German)

Activity data of gamma-ray emitting nuclides produced during in-pile neutron irradiation may be obtained by calculation starting from the neutron flux, by using flux indicators, or by direct measurements of the targets irradiated. All these determinations except the direct measurements give an accuracy worse than ±10%. (auth)

6656 SOME SIMPLE R_5 WIGNER COEFFICIENTS AND THEIR APPLICATION. K. T. Hecht (Universitet, Copenhagen). Nucl. Phys., 63: 177-213(Mar. 1965).

Generalized R_5 Wigner coefficients are calculated in algebraic form for the Kronecker products of an arbitrary irreducible representation with the 4, 5 and 10-dimensional irreducible representations of R_5, the group of rotations in 5-dimensional space. These are expressed in terms of the mathematically natural quantum numbers associated with the group chain $R_5 \supset R_4 \equiv R_3 \times R_3$. The transformation to physically interesting quantum numbers is discussed for two applications. The first involves the seniority force for nuclei with both protons and neutrons and the possibility of extracting the N and T dependence of nuclear matrix elements in the seniority scheme. (N and T are the nucleon number and the total isospin). The second application involves the calculation of fractional parentage coefficients for spin-2 phonons in the seniority scheme, for large phonon number N and seniority v. Properties of the generalized Wigner coefficients are used to relate all such fractional parentage coefficients to those of type $\langle N-1 = v-1 \| N = v \rangle$. A general prescription is given for the calculation of this type of coefficient from the R_5 Wigner coefficients, and numerical tables are given for v = 5 and 6. (auth)

6657 THE ROLE OF ISOSPIN IN PAIR CORRELATIONS FOR CONFIGURATIONS OF THE TYPE $(j)^N$. J. C. Parikh (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys., 63: 214-32(Mar. 1965).

A system of N nucleons in the $(j)^N$ configuration with a pairing interaction between them, is studied. The model Hamiltonian has a non-vanishing matrix element between two nucleon states with total angular momentum J = 0 and total isospin T = 1. The group properties of the model are examined; they lead to the description of the system in the seniority and the reduced isospin coupling scheme of Flowers. General expressions for the energy spectrum, the matrix elements of magnetic moment, and quadrupole moment operators are obtained by the methods of group theory. (auth)

6658 ENERGY LEVELS OF Pm^{149}. C. H. Chen and R. G. Arns (State Univ. of New York, Buffalo). Nucl. Phys., 63: 233-40(Mar. 1965).

The gamma rays of ^{149}Pm following the beta decay of ^{149}Nd were studied using fast-slow coincidence techniques. A total of 18 gamma rays were identified. Levels are established in ^{149}Pm at 114, 188, 210, 265, 386, 535, 650, and 750 kev. The gamma-gamma directional correlation of the 270-265 kev cascade was measured, and the expansion coefficients were found to be $A_2 = -0.22 \pm 0.01$ and $A_4 = 0$. The energy levels found are discussed in terms of recent nuclear models. (auth)

6659 THE DECAY OF 14.6 h ^{86}Y. B. Van Nooijen, W. Lourens, H. Van Krugten, and A. H. Wapstra (Laboratorium voor Technische Fysika, Delft, Netherlands). Nucl. Phys., 63: 241-62(Mar. 1965).

The decay of ^{86}Y was investigated using beta and gamma spectrometers, a gamma-gamma directional correlation arrangement, and gamma-gamma and beta-gamma coincidence systems. Six positron branches and twenty-nine gamma rays were found. A decay scheme is proposed, and spin and parity assignments are made for several levels in ^{86}Sr. This disintegration scheme is compared with previously reported experimental results and with theoretical predictions. (auth)

6660 ELECTRON CAPTURE RATIOS IN Cd^{109} AND INTERNAL CONVERSION COEFFICIENTS IN Ag^{109m}. H. Leutz, K. Schneckenberger, and H. Wenninger (Universität, Heidelberg). Nucl. Phys., 63: 263-72(Mar. 1965).

The following electron capture ratios in ^{109}Cd were determined using NaI(Tl) crystals containing ^{109}Cd: $(P_L + P_{M,N,..})/P_K = 0.228 \pm 0.003$, $P_L/P_K = 0.195 \pm 0.005$, and $P_{M,N,..}/P_L = 0.17 \pm 0.005$. A transition energy of 93.8 ± 4 kev or, taking into account the effect of electron exchange, 104 ± 4 kev between ^{109}Cd and ^{109m}Ag was calculated from the P_L/P_K capture ratio. With ^{109}Cd sources centered in the hole of a NaI(Tl) crystal or evaporated on the cleavages of anthracene split crystals, the following internal conversion coefficients were obtained: $\alpha_{total} = 24.7 \pm 0.5$, $\alpha_K = 11.0 \pm 0.3$, $\alpha_L = 11.7 \pm 0.8$, and $\alpha_{M,N,..} = 2.0 \pm 1.1$. The measured decay curve of ^{109}Cd yields a half life of 453 ± 2 days. (auth)

6661 NUCLEAR SPECTROSCOPY OF THE ISOTOPES OF Nb, Mo, AND Tc. K. H. Bhatt and J. B. Ball (Oak Ridge National Lab., Tenn.). Nucl. Phys., 63: 286-304(Mar. 1965). (ORNL-P-109)

Low-lying energy levels in isotopes of Nb, Mo, and Tc arising from the coupling of protons in the $1g_{9/2}$ level and neutrons in the $2d_{5/2}$ level are calculated by the use of effective interactions. The required two-body residual interactions are derived from the experimental data on ^{92}Zr, ^{92}Nb, and ^{92}Mo. A comparison with available experimental data shows good correspondence and indicates that the consideration of ^{90}Zr as a core state is a reasonable assumption. The simple model serves as a good basis for interpretation of the levels observed in these isotopes. (auth)

6662 THE DECAY OF Tb^{158} (150 y) TO LEVELS IN Gd^{158} AND Dy^{158}. F. Schima, E. G. Funk, Jr., and J. W. Mihelich (Univ. of Notre Dame, Notre Dame, Ind.). Nucl. Phys., 63: 305-22(Mar. 1965). (COO-498-42)

The long-lived ^{158}Tb electron-capture decay to levels in ^{158}Gd and beta decay to levels in ^{158}Dy were studied using scintillation spectrometers, Ge and Si semiconductor detectors, gamma-gamma and negaton coincidence measurements, directional correlation techniques, and half-life measurements. The gamma transitions (with total intensities in per cent of total Tb decays) observed are 79.5 (83.8%), 182(12.5%), 782(9.9%), 928(0.2%), 946(46.7%), 964 (22.2%), 1110(2.2%), and 1190 kev (1.8%), in Gd; 99.0(14.5%) and 218 kev (1.4%) in Dy. The K conversion coefficient measurements and directional correlation measurements are consistent with E1 assignments for the 782, 946, and 964 kev transitions. The following levels in ^{158}Gd were

established or confirmed: 79.5(2^+, $T_{½}$ = 2.47 nsec), 262(4^+), 1026(2^-), 1044(3^-, K = 1), and 1190 kev (2^+, K = 2). The decay proceeding to the 1190-kev level is >95% L electron capture. An 857 ± 27-kev beta branch (log ft = 12.1) proceeds to the 99.0 kev (2^+, $T_{½}$ = 1.64 nsec) level in Dy. A weak inner beta branch (<1.5%) feeds the 317-kev (4^+) level in ^{158}Dy. Comparisons are made with the theoretical estimates for the transition branching ratios for K forbidden transitions. (auth)

6663 DEFORMED BINDING FIELDS. I. THE EFFECT OF TENSOR FORCES. N. Freed and Paul Goldhammer (Univ. of Nebraska, Lincoln). Nucl. Phys., 63: 323-6 (Mar. 1965).

A variational method is applied to simple two-body problems involving tensor forces. The trial function is taken to be a linear combination of Hill-Wheeler integrals, representing the possible rotational bands which are consistent with the absolute quantum numbers. It is found that this approach closely reproduces the result of third-order perturbation theory. (auth)

6664 THE PRECISION DETERMINATION OF SOME γ-RAY ENERGIES USING A β-SPECTROMETER. G. Murray, R. L. Graham, and J. S. Geiger (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Phys., 63: 353-82 (Mar. 1965).

The energies of several γ rays which are frequently used as calibration standards in nuclear spectroscopy were determined with an accuracy of $\approx 4:10^5$ using the methods of internal and external conversion in conjunction with the iron-free $\pi\sqrt{2}$ β-spectrometer. The effects on the positions of internal and external conversion lines arising from the finite thickness of the radioactive sources and radiators and from natural width and angular correlation phenomena were investigated in some detail. The β-spectrometer was calibrated with the internal and external conversion lines of the 411.795 ± 0.009 kev γ ray in ^{198}Hg. The γ-ray energy values obtained using the 1963 least-squares adjusted physical constants are: ^{208}Pb 583.139 ± 0.023 kev; ^{208}Pb 2614.47 ± 0.10 kev; ^{60}Ni 1173.23 ± 0.04 kev; ^{60}Ni 1332.48 ± 0.05 kev; ^{24}Mg 1368.53 ± 0.04 kev; and ^{24}Mg 2753.92 ± 0.12 kev. The energy values of seven γ rays in ^{192}Pt are also reported. (auth)

6665 THE STRUCTURE OF THE GIANT DIPOLE RESONANCE. III. FLUCTUATIONS AND DIRECT INTERACTION IN LIGHT NUCLEI. N. W. Tanner (Oxford Univ.). Nucl. Phys., 63: 383-92(Mar. 1965).

Data on the structure and angular distribution of the radiative capture of protons by seven light nuclei are summarized and analyzed in terms of the theory of statistical fluctuations and compared with direct radiative capture calculations. It is concluded that: Much of the structure observed in (p,γ) measurements has no great significance for the giant dipole resonance, being in fact due to weak compound nucleus effects interfering with a dominant direct interaction. A giant quadrupole resonance probably exists which may be due to simple radiative capture of the proton into a potential well. The giant dipole resonance, although probably a direct (i.e. short lifetime) phenomenon, is not due to simple capture into a potential well but must involve a few scatterings of the ingoing proton by nucleons of the target which serve to concentrate the resonance strength at higher excitation. (auth)

6666 CROSS-SECTIONS FOR THE REACTIONS $Cu^{63}(n,\alpha)Co^{60}$, $Ni^{60}(n,p)Co^{60}$, $Ti^{46}(n,p)Sc^{46}$, AND $Na^{23}(n,2n)Na^{22}$. H. Liskien and A. Paulsen (EURATOM, Geel, Belg.). Nucl. Phys., 63: 393-400(Mar. 1965).

Absolute activation cross sections for the reactions $^{63}Cu(n,\alpha)^{60}Co$, $^{60}Ni(n,p)^{60}Co$, $^{46}Ti(n,p)^{46}Sc$, and $^{23}Na(n,2n)^{22}Na$ were determined in the energy range 12.5 to 16.5 Mev. Monoenergetic neutrons were obtained from the $T(d,n)^4He$ reaction at 1 Mev deuteron energy. The very low induced specific activities were detected by a coincidence counting technique. For comparison, statistical model calculations from 5 to 20 Mev neutron energy were performed taking into account second particle emission. (auth)

6667 THE MAGNETIC MOMENTS OF NUCLEI WITH A CLOSED SHELL PLUS OR MINUS ONE NUCLEON. Munetake Ichimura and Koichi Yazaki (Tokyo Univ.). Nucl. Phys., 63: 401-24(Mar. 1965).

The deviations of the observed values of the magnetic moments from the Schmidt values are considered for nuclei with a doubly closed shell plus or minus one nucleon in L-S coupling. To explain the origin of these deviations, an estimate is made of the contributions from the configuration mixing by the second-order perturbation and those of the meson exchange current. The results are given in the form of a renormalization factor for the gyromagnetic ratios. The calculated deviations for ^{15}N and ^{17}O are in the correct direction but too large; that for ^{41}Ca is consistent with experiment. (auth)

6668 PROPERTIES OF THE 418 kev LEVEL IN I^{127}. H. Langhoff (Franklin Inst., Swarthmore, Penna.). Nucl. Phys., 63: 425-37(Mar. 1965).

Using the centrifuge technique, resonance fluorescence from the 418-kev level in ^{127}I was observed. The angular distribution of the 418-kev radiation emitted by a ^{127}Te source and resonantly scattered from an iodine scatterer was determined to be $W(\theta) = 1 + (0.22 \pm 0.07)\cos^2\theta$. Since this result does not discriminate between the possible spin assignments $^5/_2$ and $^3/_2$ for the 418-kev level, the linear polarization P of the resonantly scattered radiation was measured. The result of P = 18 ± 6% is only compatible with spin $^5/_2$. The experimental cross section for resonance fluorescence yields $\tau = (4.6 \pm 0.4) \cdot 10^{-12}$ sec for the mean lifetime of the 418-kev level. A comparison of the known M1 transition probabilities for the γ transitions in ^{127}I with theoretical predictions from the Kisslinger-Sorensen model shows rather good agreement, while the E2 transitions in general are faster than predicted. (auth)

6669 SOME EXCITATION FUNCTIONS OF NEUTRON INDUCED REACTIONS IN THE ENERGY RANGE 12.6–19.6 Mev. M. Bormann (Universität, Hamburg), E. Fretwurst, P. Schehka, G. Wrege, H. Buettner, A. Lindner, and H. Meldner. Nucl. Phys., 63: 438-48(Mar. 1965).

Excitation functions of neutron induced reactions were measured in the energy range 12.6–19.6 Mev by means of the activation method. Results for the following reactions are reported: (n,2n) reaction in ^{14}N, ^{19}F, ^{39}K, ^{69}Ga, and ^{88}Sr, (n,p) reaction in ^{19}F and ^{66}Zn and (n,α) reaction in ^{55}Mn. The results are compared with corresponding measurements published by others. In the case of the heavier target elements a comparison is also made with the predictions of the statistical theory using compound nucleus cross sections evaluated in the optical model and applying the level density formula given by Lang. Gamma emission as a competing process in the decay of the compound nucleus is also taken into account. The agreement of the theoretical predictions with the experimental results is poor. This, probably, is caused mainly by the level density parameters. (auth)

6670 SYMPLECTIC SYMMETRY IN $f_{⅞}$ SHELL NUCLEI. J. N. Ginocchio (Univ. of Rochester, N. Y. and Oak Ridge National Lab., Tenn.). Nucl. Phys., 63: 449-65(Mar. 1965). (UR-875-43)

The status of the conservation of symplectic symmetry in the nuclear $f_{⅞}$ shell is investigated by comparing the two-body interaction with the most general symplectic-conserving interaction using an a priori criterion developed for the purpose, by examining symplectic admixtures in the calculated nuclear wave functions, and by studying the calculated symplectic energy bands. The interaction is determined from the best available data of the ^{42}Sc spectrum. It is concluded that, except in special cases, symplectic symmetry is not approximately conserved and predictions based on a simple symplectic model are therefore invalid. Some comments are made concerning an alternative approach for studying the structure of the j^n configuration. (auth)

6671 COLLECTIVE LEVELS OF W, Os, AND Pt STUDIED BY GAMMA-RAY SPECTROSCOPY OF (α,xn) REACTIONS. Neil L. Lark and H. Morinaga (Institut

voor Kernphysisch Onderzoek, Amsterdam). Nucl. Phys., 63: 466-76(Mar. 1965).

Studies of gamma-ray spectra accompanying (α,xn) nuclear reactions were extended to a wide range of types of nuclei. Strongly selective population of the lowest-energy highest-spin collective states was established as the general systematic behavior when the final product is an even nucleus. This technique was then applied to a systematic study of the collective excited states of the neutron-deficient even isotopes of tungsten, osmium, and platinum which span the transition from deformed rotational to spherical vibrational nuclei. Gamma-ray energies, energy levels, probable spin and parity assignments up to 8^+ or 10^+ or 12^+ and cross sections for populating these levels are reported for ^{178}W, ^{179}W, ^{180}W, ^{180m}W, ^{182}W, ^{182}Os, ^{182m}Os, ^{184}Os, ^{186}Os, ^{188}Os, ^{188}Pt, ^{190}Pt, ^{192}Pt, and ^{194}Pt. (auth)

6672 THE GYROMAGNETIC RATIO OF THE FIRST EXCITED 2^+ STATE OF Pt^{194}. H. Spehl, O. Klepper, and H. Roepke (Universität, Freiburg i. B.). Nucl. Phys., 63: 477-80(Mar. 1965).

The gyromagnetic ratio of the 328.5-kev state of ^{194}Pt was measured using a metallic target of enriched ^{194}Pt. The state was excited by Coulomb excitation with a neutral hydrogen beam of 2.55 Mev. Due to the short lifetime, there is essentially no perturbation of the γ-ray angular distribution. The precession of the distribution was measured in an external magnetic field of 41,600 G. The gyromagnetic ratio was found to be $g \cong 0.33$. (auth)

6673 ELECTRO-EXCITATION OF GIANT RESONANCE LEVELS IN Si^{28}. J. B. Seaborn and J. M. Eisenberg (Univ. of Virginia, Charlottesville). Nucl. Phys., 63: 496-503(Mar. 1965).

Form factors were calculated for the electro-excitation of E1, T = 1, levels in ^{28}Si using wave functions derived from the particle-hole model. The transverse electric form factors of the various levels show distinctively different behavior as functions of momentum transfer. The results are compared with the available experimental data. (auth)

6674 THE TWO-NUCLEON TRANSFER REACTION $Ca^{40}(d,\alpha)K^{38}$. S. Micheletti and P. Mukherjee (Univ. of Pittsburgh). Nucl. Phys., 63: 504-12(Mar. 1965).

The reaction $^{40}Ca(d,\alpha)^{38}K$ was studied with 14.8 Mev deuterons. Angular distributions of alpha particles to several levels of ^{38}K were obtained and are compared with two-nucleon pick-up theories. (auth)

6675 THE FEW-NUCLEON SYSTEMS WITH VELOCITY-DEPENDENT POTENTIALS. R. Folk (Lehigh Univ., Bethlehem, Penna. and Oak Ridge National Lab., Tenn.) and E. Bonnem. Nucl. Phys., 63: 513-19(Mar. 1965). (ORNL-P-209)

The calculated binding energies and rms radii are given for the ground states of the three and four-nucleon systems for nine assumed central potentials. Two of the potentials have hard cores and six have velocity-dependent terms. The results are grouped according to the S-state phase shifts produced by the potentials in the two-body system. The properties of the three and four-nucleon systems are correlated very sensitively with the S-state phase shifts for laboratory energies below 100 Mev and are independent of the type of potential involved. (auth)

6676 PHOTOEXCITATION OF M1 AND E2 LEVELS IN O^{16}. B. M. Spicer and J. M. Eisenberg (Univ. of Virginia, Charlottesville). Nucl. Phys., 63: 520-5(Mar. 1965).

The 1^+ and 2^+ states in ^{16}O were studied using the particle-hole model, in an attempt to understand better the structure in the giant resonance region. A plausible unperturbed spectrum was obtained from data on the excited states of ^{17}O and ^{15}O. The calculation used a zero-range approximation for the residual interaction. The results are compared with experiment where possible. (auth)

6677 GAMMA-RAY SPECTRA FROM INELASTIC NEUTRON SCATTERING IN Ta AND Au AT 5.5 AND 7.5 MEV. J. L. Perkin (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.) and N. Starfelt. Nucl. Phys., 63: 526-8(Mar. 1965).

Gamma spectra from inelastic neutron scattering in Ta and Au were measured at neutron energies of 5.5 and 7.5 Mev. The results were compared with spectra calculated from the shapes of the neutron capture γ ray spectra from these elements. (auth)

6678 THE THERMAL NEUTRON-CAPTURE CROSS SECTION AND RESONANCE-CAPTURE INTEGRAL OF Ru^{106}. R. D. Werner and T. A. Eastwood (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Nucl. Sci. Eng., 21: 20-5(Jan. 1965).

The thermal-neutron capture cross section of 1.0-year ^{106}Ru was determined from the yield of 22-min ^{107}Rh formed in reactor irradiations. The average of four measurements is 0.146 barns. The experimental error is about ±7%, but when systematic errors are included, largely in gamma abundances from ^{106}Ru and ^{107}Rh decay, the uncertainty is about 30%. Cadmium-ratio measurements were made; and the resonance capture integral, including the 1/v part, was found to be 2.0 ± 0.6 barns for an effective cadmium cutoff of 0.54 ev. These results are relative to a cobalt thermal-neutron capture cross section of 37.5 barns and a total resonance integral of 72.7 barns. It was assumed that neutron capture by ^{106}Rh, ^{107}Ru, and ^{107}Rh is negligible, that the cross section of ^{106}Ru in the thermal region has a 1/v dependence, and that the neutron spectrum is 1/E in the resonance region. (auth)

6679 ACTIVATION CROSS SECTION FOR KRYPTON-83m. S. L. Ruby and R. Ellefson (Argonne National Lab., Ill.). Nucl. Sci. Eng., 21: 114(Jan. 1965).

The neutron activation cross section for 1.9-hr ^{83}Kr was measured to be 3 ± 1 barn. (D.C.W.)

6680 ELASTIC SCATTERING OF POLARIZED PROTONS BY ^{16}O. C. Manduchi, G. C. Nardelli, M. T. Russo-Manduchi, and G. Zannoni (Università, Padua and Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cimento (10), 34: 860-8(Nov. 16, 1964).

The angular dependence of the polarization resulting from the elastic scattering of protons by ^{16}O was measured for proton energies between 4.27 and 4.84 Mev at laboratory angles ranging from 50 to 130°. The results are in general agreement with those predicted by the best available sets of phase shifts. (auth)

6681 MUON CAPTURE IN NUCLEI. L. L. Foldy and J. D. Walecka (CERN, Geneva). Nuovo Cimento (10), 34: 1026-61(Nov. 16, 1964).

The total meson (μ) capture rates for some light nuclei (^{40}Ca, ^{16}O, ^{12}C and ^4He) were calculated, taking into account the effect of the giant dipole resonances in the capture process. The results were compared with experimental observations. (D.C.W.)

6682 FURTHER EXCITED STATES OF OXYGEN 16. G. F. Nash (Wadham Coll., Oxford). Nuovo Cimento (10), 34: 1061-72(Nov. 16, 1964).

The doubly excited states of ^{16}O were classified by their unitary and supermultiplet quantum numbers, and the excitation energies of some [44431] states were evaluated using a Wigner relative-state force. The distribution of the quadrupole strength between these states was determined. The effect of an exchange mixture on selected two; three; and four-nucleon excited states was examined. (auth)

6683 NUCLEAR RESONANT SCATTERING OF GAMMA-RAYS IN Pb, Ni, Cd. M. Giannini, P. Oliva, D. Prosperi, and S. Sciuti (CNEN, Rome). Nuovo Cimento (10), 34: 1116-18(Nov. 16, 1964).

The scattering of gamma rays from the (n,γ) reaction was investigated using four source-scatterer combinations: Fe–Pb, Fe–Ni, Al–Pb, and Fe–Cd. Absorption and scattering cross sections, full widths, partial widths for radiative decay to the ground state, and distances between the absorption and emission lines were obtained. The observed resonances were attributed to ^{114}Cd and ^{62}Ni. (D.C.W.)

6684 RANGE OF NUCLEAR FORCE DUE TO EXCHANGE OF ABC PARTICLE AS A VIRTUAL LEVEL.

Y. Fujii and H. Yabuki (Tokyo Univ.). Nuovo Cimento (10), 34: 1131-3(Nov. 16, 1964).

It is shown that a virtual level in the S-state two-pion system gives a force range somewhat smaller than that expected from a simple application of the uncertainty relation between energy and time. (D.C.W.)

6685 Sn^{116} LEVELS POPULATED BY THE DECAY OF 54-Min In^{116m}. H. H. Bolotin (Argonne National Lab., Ill.). Phys. Rev., 136: B1557-65(Dec. 21, 1964).

The decay of the 54-min ^{116}In isomer was investigated by means of scintillation singles and coincidence spectroscopy techniques. Angular-correlation measurement of four pairs of successive γ rays served as a basis for the assignment of the spin and parity of all levels, and the multipole order of all transitions. The excitation energies (Mev, relative to the 0^+ ground state) and characters (J^π) of the observed levels were 3.06 (4^+), 2.78 (4^+), 2.53 (4^+), 2.38 (4^+), 2.12 (2^+), 1.72 (0^+), and 1.29 (2^+). In addition, two new transitions with energies of 0.385 and 0.435 Mev were observed to feed and depopulate, respectively, the level at 1.72 Mev. The relative intensities of all transitions are presented. The experimental results are compared with previously reported work and are discussed in the light of pairing-force calculations. All levels populated in this decay, with the exception of the 1.29-Mev first excited state, were found to be distinctly different from those populated in the same nuclide by the decay of 1-hr ^{116}Sb. These findings are discussed, and arguments are presented to account for these differences. (auth)

6686 LEVEL STRUCTURE OF Sn^{116} FROM THE DECAY OF 1-h Sb^{116}; AND A DETAILED COMPARISON OF Sn^{116}, Sn^{118}, AND Sn^{120} WITH PAIRING-FORCE CALCULATIONS. H. H. Bolotin (Argonne National Lab., Ill.). Phys. Rev., 136: B1566-79(Dec. 21, 1964).

The decay of 1-hr ^{116}Sb was studied. The spins, parities, and multipole orders of all levels and transitions observed in ^{116}Sn are characterized as 2.90 Mev, 7^-; 2.76 Mev, 6^-; 2.35 Mev, 5^-; 2.25 Mev, 3^-; 1.29 Mev, 2^+; $7^- \rightarrow 6^-$, M1; $6^- \rightarrow 5^-$, M1; $5^- \rightarrow 3^-$, E2; $5^- \rightarrow 2^+$, E3; $2^+ \rightarrow 0^+$, E2. In addition, a strong 0.545-Mev E2 transition ($7^- \rightarrow 5^-$) was observed. The assignments of spin and multipole order were determined from angular-correlation and internal-conversion measurements. All β decay was found to proceed exclusively to the 7^- level. The half-life of the 5^- (2.35-Mev) state was determined to be $(2.3 \pm 0.2) \times 10^{-7}$ sec by use of delayed-coincidence techniques. The 7^- level at 2.90 Mev, previously reported to have a half-life greater than 10^{-7} sec, was found to be prompt ($t_{\frac{1}{2}} < 2 \times 10^{-9}$ sec). Triple-coincidence measurements determined a β^+-to-capture ratio of 0.237 ± 0.011, from which the transition energy was inferred to be 2.11 ± 0.03 Mev. A complete systematic summary, determined experimentally, for ^{116}Sn, ^{118}Sn, and ^{120}Sn, as populated by the corresponding Sb isotopes, is compared with the latest detailed pairing-force calculations. In addition, the experimentally determined reduced transition probabilities in each of these nuclides are compared with the predictions of this theory. (auth)

6687 DETERMINATION OF RADIATIVE TRANSITION WIDTHS OF EXCITED STATES IN C^{12}. H. L. Crannell and T. A. Griffy (Stanford Univ., Calif.). Phys. Rev., 136: B1580-4(Dec. 21, 1964).

New absolute values for the elastic and inelastic electron scattering cross sections from ^{12}C are presented for a range of q^2 from 0.75 to 3.14 F^{-2}. A method of analysis has been employed to obtain the radiative widths for the first three excited states in ^{12}C from the measured inelastic cross sections. This method of analysis does not depend on a model for the transition charge distribution and is useful in determining the multipolarity of the transition. (auth)

6688 EXCITED STATES OF IODINE-127. S. Jha and R. Leonard (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 136: B1585-90(Dec. 21, 1964).

The lifetime of the 59-kev first excited state of ^{127}I has been measured using both xenon and tellurium parents. An average of the two results is 1.8 ± 0.3 nsec. In addition, angular correlation studies have shown the multipolarity of the 59-kev gamma ray to be predominantly magnetic dipole with an electric quadrupole admixture of $0.6 \pm 0.6\%$. Angular correlation studies have also been carried out on two other cascades of ^{127}I. One of these, the 175–200-kev cascade, showed an anisotropy of $5 \pm 3\%$ when the ^{127}Xe source was in the gaseous form; but when the source was adsorbed on charcoal, an anisotropy of 30% was found. The smearing of the angular correlation is attributed to the highly ionized states of the gamma emitters resulting from electron capture. The other, the 356–59-kev cascade, exhibited an anisotropy of 0.498 ± 0.07 after geometric corrections. This permits assignment of the value $\frac{5}{2}$ for the spin of the 415-kev state, while the 356 kev gamma ray is either 9.3 or 85% electric quadrupole, depending on which of the two possible solutions is selected. The lifetime of the 59-kev state after correction for internal conversion is longer by a factor 67 ± 14 than predicted by the Weisskopf estimate for an allowed magnetic dipole transition. This is consistent with the values observed for other l-forbidden M1 transitions and with theoretical estimates. (auth)

6689 RESONANCE FLUORESCENCE IN Ir^{191}. H. Langhoff (Franklin Inst., Swarthmore, Penna.). Phys. Rev., 136: B1590-3(Dec. 21, 1964).

Resonance fluorescence from ^{191}Ir has been investigated with ^{191}Pt as the source of the exciting radiation. The centrifuge technique was used for compensation of the recoil energy losses. The level at 539 kev was excited and a mean lifetime of $(1.1^{+0.3}_{-0.3}) \times 10^{-11}$ sec was determined. A second level excited at (590 ± 15) kev might be identical with that suggested at 584 kev. The limits for the mean lifetime τ are $5 \times 10^{-13} < \tau < 1.5 \times 10^{-11}$ sec. No resonance fluorescence was observed from the 625-kev level. The small transition probabilities for the γ transitions from the 539- and the 625-kev levels to the ground-state band are not compatible with the previous assignment to Nilsson orbit (402)↑. A satisfactory agreement with the Nilsson model was obtained by assuming that these levels belong to the rotational band built on Nilsson state (411)↑. (auth)

6690 APPLICATION OF THE REFERENCE-SPECTRUM METHOD TO THE NUCLEAR SURFACE. B. D. Day (Univ. of California, Los Angeles). Phys. Rev., 136: B1594-1608(Dec. 21, 1964).

The reference-spectrum method for infinite nuclear matter is generalized in a simple way so as to apply to the surface region of a large nucleus. This permits one to calculate the reaction matrix for particles interacting in the surface region, and the total energy of the nucleus can therefore be found to first order in the Brueckner-Goldstone expansion. Two equivalent formulas for the nuclear surface energy, both valid to first order in the Brueckner-Goldstone expansion, are derived and discussed. These results are then used to calculate the surface energy of a large nuclear slab. The single-particle wave functions are calculated in a Woods-Saxon potential which is chosen to reproduce the empirical surface thickness; and the two-body interaction, which acts only in S states, is assumed to consist of an exponential attraction outside a hard core. The calculation gives the reasonable value of 20.6 $A^{\frac{2}{3}}$ Mev for the surface term in the semiempirical mass formula. The chief defect of this trial calculation is the lack of self-consistency in the one-particle wave functions. A self-consistent calculation would give a more reliable estimate for the surface energy and would also predict the surface thickness theoretically. A brief discussion is given of how these methods could be used to attack the self-consistency problem. (auth)

6691 MODERATION AND ABSORPTION TIMES FOR NEGATIVE PIONS IN LIQUID DEUTERIUM. J. H. Doede, R. H. Hildebrand, and M. H. Israel (Argonne National Lab., Ill. and Univ. of Chicago). Phys. Rev., 136: B1609-14 (Dec. 21, 1964).

The moderation and absorption times for negative pions stopping in liquid deuterium have been measured. In deuterium the mean time for a negative pion to go from an

initial velocity $v_0 \leq 0.006c$ to nuclear capture was found to be $(2.1 \pm 0.5) \times 10^{-12}$ sec. The relationship of this capture time to that for liquid hydrogen, $(2.3 \pm 0.6) \times 10^{-12}$ sec, is discussed in detail. Results are also presented for the moderation times of pions with initial velocities between 0.05c and 0.006c. (auth)

6692 MAGNETIC MOMENT OF THE 26.8-kev STATE OF ^{129}I MEASURED WITH THE AID OF SUPERCONDUCTING MAGNETS. H. de Waard and Juergen Heberle (Argonne National Lab., Ill.). Phys. Rev., 136: B1615-17 (Dec. 21, 1964).

The magnetic moment of the 26.8-kev state in ^{129}I has been determined from the Zeeman effect of the 26.8-kev gamma line in an external field. The line was observed in a Mössbauer spectrometer with a vibrating $^{66}Zn^{129}Te$ source cooled by liquid nitrogen. A $K^{129}I$ absorber was mounted in a 50-kG superconducting magnet immersed in liquid helium. The absorption spectrum of the $^7/_2^+ \rightarrow {}^5/_2^+$ transition consists of twelve Zeeman components when observed in the direction of the magnetic field. These components could not be resolved because their spacings are less than a linewidth. The shape of this unresolved spectrum, however, depends sensitively on the ratio of the magnetic moment of the excited state to that of the ground state. Analysis of such spectra by curve-fitting techniques yields $+2.84 \pm 0.05$ nm for the magnetic dipole moment of the 26.8-kev state. (auth)

6693 ^{4}He AND ^{3}He PARTICLES FROM Au, Bi, AND Th NUCLIDES BOMBARDED BY 157-Mev PROTONS. H. Dubost, M. Lefort, J. Peter, and X. Tarrago (Université de Paris, Orsay, France). Phys. Rev., 136: B1618-23 (Dec. 21, 1964).

Energy distribution measurements have been carried out for ^{4}He and ^{3}He at different angles when Au, Bi, and Th targets are bombarded by 157-Mev protons. The telescope method was applied to solid-state detectors. The angular distribution has two components. The first, due to an isotropic process, is attributed to the evaporation mechanism. The second, preferentially in the forward direction, is taken as evidence for a knock-out mechanism. Prompt cascade nucleons are believed to be scattered by α clusters on the surface of the nucleus and to eject α particles. About 40 nucleons may be organized in α clusters in heavy nuclei. (auth)

6694 PROTONS FROM THE DEUTERON BOMBARDMENT OF HELIUM-4. G. G. Ohlsen and P. G. Young (Australian National Univ., Canberra). Phys. Rev., 136: B1632-9(Dec. 21, 1964).

Proton spectra from the bombardment of ^{4}He with deuterons between 7.7 and 11 Mev have been obtained. A binding energy of -0.93 ± 0.07 Mev and a width of 0.57 ± 0.02 Mev are obtained for the ^{5}He ground state. A ^{4}He(d,p) $\times$ ^{5}He excitation function over the ^{6}Li excitation-energy range from 6.5 to 8.7 Mev failed to confirm the existence of the proposed 7.4-Mev, T = 0 level. An extrapolation and integration of the measurements yields an estimate for the total reaction cross section of 460 ± 80 mb at 10 Mev and 460 ± 50 mb at 11 Mev. (auth)

6695 GAMMA RAYS FROM THERMAL NEUTRON CAPTURE IN Cl, V, Mn, AND Co. O. A. Wasson, K. J. Wetzel, and C. K. Bockelman (Yale Univ., New Haven). Phys. Rev., 136: B1640-53(Dec. 21, 1964).

The high-energy γ rays ($E_\gamma > 5$ Mev) emitted in thermal-neutron capture by Cl, V, Mn, and Co have been observed with 20-kev resolution using a single lithium-drifted germanium detector and paraffin-moderated Pu–Be neutrons. The ground-state γ rays in Mn and V are found to contain primary transitions to the first excited states near 20-kev excitation. In addition, previously unreported lines in all four elements have been observed; most of these have been identified as primary transitions to levels known from (d,p) studies. Little correlation between the reduced γ-ray strengths I_γ/E_γ^3 from the (n,γ) reaction, and the relative transition strengths (2J + 1)S from the (d,p) reaction, is observed in Co and V. (auth)

6696 QUADRUPOLE MOMENTS OF ODD-NEUTRON NUCLEI; SPIN AND MOMENTS OF 14-YEAR Cd^{113m}. F. W. Byron, Jr., M. N. McDermott, R. Novick, B. W. Perry, and E. B. Saloman (Columbia Univ., New York). Phys. Rev., 136: B1654-61(Dec. 21, 1964).

The nuclear spin and hfs in the (5s5p) $^3P_1$ state of 14-year ^{113m}Cd have been measured by the optical double-resonance technique. The isotope was produced by the reaction $^{112}Cd(n,\gamma)^{113m}Cd$. After irradiation, the ^{113m}Cd was separated from the ^{112}Cd with an electromagnetic mass separator. The nuclear spin I, and the hfs separations are: $I = {}^{11}/_2$; $\nu({}^{13}/_2 - {}^{11}/_2) = 4310.572(5)$ Mc/sec; $\nu({}^{11}/_2 - {}^{9}/_2) = 3949.625(7)$ Mc/sec. The hfs coupling constants, corrected to second order for interaction with the $^3P_2$ and $^3P_0$ states, are: A(113m) = –686.0425(8) Mc/sec; B(113m) = +169.047(9) Mc/sec. If we neglect nuclear structure and quadrupole shielding effects, the nuclear moments are: $\mu(113m) = -1.08885(13)\mu_N$; Q(113m) = –0.79(10)b. The ratio of the ^{113m}Cd and ^{109}Cd quadrupole moments is Q(113m)/Q(109) = –1.02371(4); this result is independent of the shielding corrections. The spin and magnetic moment are consistent with a $(2d_{5/2})^6(1g_{7/2})^8(1h_{11/2})^1$ neutron assignment with some configuration mixing. The observed quadrupole moments in cadmium and other spherical odd-neutron nuclei ($A < 150$, $189 < A < 210$) are compared with predictions of the shell model, including configuration mixing, and with a quasiparticle model. In addition, it is shown that a certain semiempirical formula accurately predicts the quadrupole-moment ratios for the isotopes of several elements. It is found that $Q_0(Z)$ exhibits strongly oscillatory dependence on the nuclear charge Z with minima near the magic proton numbers. It is suggested that $Q_0(Z)$ may be interpreted in terms of the quadrupolar polarizability of the proton core. (auth)

6697 POLARIZATION IN p-C^{12} ELASTIC SCATTERING. L. Drigo, C. Manduchi, G. C. Nardelli, M. T. Russo-Manduchi, and G. Zannoni (Università, Padua and Istituo Nazionale di Fisica Nucleare, Padua). Phys. Rev., 136: B1662-7(Dec. 21, 1964).

A systematic investigation has been carried out on the angular dependence of the polarization resulting from the elastic scattering of protons by ^{12}C nuclei, at laboratory angles ranging from 45 to 135° for proton energies between 3.78 and 4.66 Mev. The results are somewhat different from the predictions of phase-shift analysis of elastic-scattering angular distributions. It was found that this disagreement may be explained by making small changes in the phase shifts without seriously affecting the fit to the angular distributions. (auth)

6698 DYNAMIC CALCULATIONS OF FISSION OF AN AXIALLY SYMMETRIC LIQUID DROP. I. Kelson (Weizmann Inst. of Science, Rehovoth, Israel and Atomic Energy Commission, Yavne, Israel). Phys. Rev., 136: B1667-73(Dec. 21, 1964).

A dynamical treatment for an axially symmetric liquid drop is presented. A general parametrization of the nuclear shape is introduced. The framework is suitable for the inclusion of a nuclear-energy term in the Hamiltonian. A particular mode of fission is solved numerically, to obtain saddle-point and scission-point shapes, and kinetic-energy distributions. (auth)

6699 INTERACTION BETWEEN THE NEUTRON MAGNETIC MOMENT AND THE NUCLEAR COULOMB FIELD IN NEUTRON POLARIZATION. J. E. Monahan and A. J. Elwyn (Argonne National Lab., Ill.). Phys. Rev., 136: B1678-81(Dec. 21, 1964).

Neutrons scattered through small angles by heavy nuclei are polarized by the interaction between the magnetic moment of the neutron and the electric field of the nucleus. Of the several approximate methods that have been used to estimate the magnitude of this effect, none are sufficiently general to permit the simultaneous consideration of a realistic nuclear potential that includes a spin-orbit interaction. Therefore such estimates are valid only for small angles of scatter ($\lesssim$5 to 10°). A more nearly exact calculation based on an optical-model potential that includes a spin-orbit term is described in this paper. The calculation is based on a generalization of the usual Born approximation. This "generalized" method can be applied to a variety of problems in which the scattering potential is sepa-

rable into a strong short-range term and a relatively weak long-range one. The results of this calculation are compared with data that originally indicated the possibility of an extranuclear contribution to the polarization of ~1.0-Mev neutrons scattered through an angle of 24°. This comparison indicates that the electromagnetic interaction can account for a substantial part of the polarization observed at this "large" angle—even for neutrons scattered from nuclei with moderate charge ($Z \gtrsim 40$). (auth)

6700 DISTORTED-WAVE BORN APPROXIMATION ANALYSIS OF $C^{12}(d,p)C^{13}$. R. van Dantzig and W. Tobocman (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev., 136: B1682-7(Dec. 21, 1964).

The $^{12}C(d,p)^{13}C$ (g.s.) reaction at 25.9-Mev deuteron energy was investigated in terms of the distorted-wave Born approximation model. The dependence of the DWBA solutions on changes of the radial form factors of the imaginary optical-model potentials, consistent with the elastic-scattering data, was studied. (auth)

6701 $Li^7(Li^7,He^6)Be^8$ REACTION. R. R. Carlson, R. L. McGrath, and E. Norbeck (Univ. of Iowa, Iowa City). Phys. Rev., 136: B1687-92(Dec. 21, 1964).

Energy spectra of ^{6}He particles emitted in the nuclear reaction $^7Li(^7Li,^6He)^8Be$ were measured using a two-parameter E-dE/dx data-taking system which incorporated a general-purpose computer. Incident ^{7}Li ions had an energy of 3.0 Mev. The energy spectra showed peaks corresponding to the ground state and first (2.9 Mev) excited state of ^{8}Be and an anomalous yield between these states. This yield is simply explained as resulting from the two-step reaction $^7Li(^7Li,\alpha)^{10*}Be$ (^{6}He)α. No evidence for direct three-body breakup is found. ^{6}He angular distributions do not exhibit strong structure; the ground-state group shows slight anisotropy. (auth)

6702 DEUTERON STRIPPING REACTION ON Mg^{26}. J. Silverstein, L. J. Lidofsky, G. E. Mitchell, and R. B. Weinberg (Columbia Univ., New York). Phys. Rev., 136: B1703-9(Dec. 21, 1964).

The reaction $^{26}Mg(d,p)^{27}Mg$ was studied at several bombarding energies between 3.0 and 5.1 Mev. Angular distributions were measured for the transitions to the ground and first three excited states in ^{27}Mg. Absolute spectroscopic factors were calculated using the distorted-wave Born approximation, and the dependence of these results on a lower cutoff radius was investigated. The results are compared to those for the $K = \frac{1}{2}$ band in ^{25}Mg. (auth)

6703 POLARIZATION AND DIFFERENTIAL CROSS SECTION FOR NEUTRONS SCATTERED FROM Li^6 AND Li^7. R. O. Lane, A. J. Elwyn, and A. Langsdorf, Jr. (Argonne National Lab., Ill.). Phys. Rev., 136: B1710-19 (Dec. 21, 1964).

The polarization and differential cross section for neutrons scattered from ^{6}Li and ^{7}Li have been measured at several angles for neutron energies from 0.2 to 2.0 Mev. The measurements indicate that for energies from about 0.5 to 2.0 Mev both ^{6}Li and ^{7}Li are useful as polarization analyzers. Attempts to explain both the differential cross section and polarization results simultaneously, for the n-^{7}Li scattering in terms of only a few levels in the compound nucleus ^{8}Li, are only partially successful. Furthermore, preliminary calculations based on an optical-model interaction for both the n-^{6}Li and n-^{7}Li scatterings do not lead to a completely successful interpretation of all the results. (auth)

6704 THRESHOLDS FOR (p,n) REACTIONS ON 26 INTERMEDIATE-WEIGHT NUCLEI. C. H. Johnson, C. C. Trail, and A. Galonsky (Oak Ridge National Lab., Tenn.). Phys. Rev., 136: B1719-29(Dec. 21, 1964). (ORNL-P-304)

Protons with energies below 5 Mev, produced by either a 3-Mv or a 5.5-Mv Van de Graaff accelerator, were used to find (p,n) thresholds and threshold limits for 26 nuclei with $37 \leq A \leq 112$. Data are presented from several independent measurements. Energy calibrations are based on one or more of the following absolute standards: $^7Li(p,n)$, 1880.7 ± 0.4 kev; $^{11}B(p,n)$ 3016.4 ± 1.5; $^{19}F(p,n)$, 4234.4 ± 1.0 kev; and $^{19}F(p,\alpha\gamma)$, 872.5 ± 0.4, 934.1 ± 0.9, 1346.6 ± 1.1, and 1373.5 ± 0.6 kev. Neutrons were detected in each experiment by several BF_3 counters in 4π geometry. The yields near threshold have been interpreted in terms of statistical theory of the compound nucleus, and in most cases there is good agreement with the predictions for the ground-state transitions. The targets and the corresponding negative Q values in kev for these ground-state transitions are as follows: ^{37}Cl, 1596.9 ± 2.5; ^{41}K, 1209.7 ± 1.5; ^{49}Ti, 1383.6 ± 1.0; ^{51}V, 1533.7 ± 1.8; ^{53}Cr, 1380.4 ± 1.6; ^{55}Mn, 1014.4 ± 0.8; ^{57}Fe, 1619 ± 2; ^{59}Co, 1855.3 ± 1.6; ^{61}Ni, 3024 ± 4; ^{65}Cu, 2135.8 ± 1.7; ^{67}Zn, 1783.3 ± 1.4; ^{69}Zn, 3707 ± 5; ^{69}Ga, 3006 ± 4; ^{70}Zn, 1439 ± 3; ^{71}Ga, 1018 ± 2; ^{74}Ge, 3348 ± 5; ^{75}As, 1647.3 ± 1.1; ^{80}Se, 2653 ± 3; ^{106}Pd, 3754 ± 13; ^{108}Pd, 2670 ± 100; and ^{112}Cd, 3400 ± 20. In addition, three thresholds were observed for which the comparison of the observed yields with the predictions indicates that the reactions proceed to the excited states in the residual nuclei. The three targets and the corresponding negative Q values in kev are as follows: ^{73}Ge, 1189 ± 15; ^{89}Y, 4207 ± 6; ^{93}Nb, 2720 ± 100. The fact that the $^{93}Nb(p,n)^{93}Mo$ threshold to the 1.48-Mev state was observed indicates that lower states in ^{93}Mo have $J \leq \frac{5}{2}$. For three other targets the yield curves showed some indication of a threshold; however, comparisons with the theory in these cases indicate that only the following upper limits can be set to $-Q$ in kev: $^{48}Ca(p,n)^{48}Sc$, <640; $^{82}Se(p,n)^{82}Br$, <920; $^{93}Nb(p,n)^{93}Mo$, <1290. A comparison with the theory indicates that the observed yield above 650 kev for ^{48}Ca must be due to a transition to an excited state rather than the ground state of ^{48}Sc. (auth)

6705 Li(d,α) REACTIONS AT DEUTERON ENERGIES BETWEEN 175 AND 300 kev. Mel Manalis and Joel E. Henkel (Univ. of New Hampshire, Durham). Phys. Rev., 136: B1741-3(Dec. 21, 1964).

The differential cross section for the reaction $^7Li(d,\alpha_0) \times {}^5$He (ground state) was measured to be 0.31 ± 0.10, 0.64 ± 0.22, 1.04 ± 0.36, 1.41 ± 0.49, and 1.71 ± 0.60 mb/sr for incident deuteron energies of 175, 214, 248, 280, and 300 kev respectively, relative to that for the reaction $^6Li(d,\alpha) \times {}^4$He. The energy dependence of the measured cross sections agreed with that for the probability of formation of the compound nucleus, calculated from continuum theory. (auth)

6706 CONFIGURATION MIXING EFFECTS IN STRIPPING. N. Austern (Univ. of Pittsburgh). Phys. Rev., 136: B1743-7(Dec. 21, 1964).

The bound "single-particle wave function" into which the stripped particle is inserted is a true single-particle wave function, in the shell-model sense, only if the target nucleus is a closed-shell nucleus. In all other cases the radial shape of this function is altered by configuration mixing effects, and important changes of cross-section magnitudes may ensue. These effects are discussed, and a detailed comparison is given with the customary phenomenological procedure wherein the configuration mixing effects are estimated in terms of the Q of the reaction. (auth)

6707 LIFETIMES OF HYPERNUCLEI, $_\Lambda H^3$, $_\Lambda H^4$, $_\Lambda He^5$. R. J. Prem and P. H. Steinberg (Univ. of Maryland, College Park). Phys. Rev., 136: B1803-6(Dec. 21, 1964). (TID-20813)

Presented are lifetime estimates for hypernuclei $_\Lambda H^3$, $_\Lambda H^4$, and $_\Lambda He^5$ based upon data obtained from an emulsion stack exposed to 2.3- and 2.5-Bev/c K^-mesons. These lifetimes are: $\tau(_\Lambda H^3) = (0.9^{+0.5}_{-0.3}) \times 10^{-10}$ sec (3 in-flight and one at-rest decays; $_\Lambda H^3 \rightarrow {}^3\text{He} + \pi^-$); $\tau(_\Lambda H^4) = (1.8^{+0.4}_{-0.3}) \times 10^{-10}$ sec (3 in-flight and 4 at-rest decays; $_\Lambda H^4 \rightarrow {}^4\text{He} + \pi^-$); $\tau(_\Lambda He^5) = (1.4^{+1.0}_{-0.5}) \times 10^{-10}$ sec (3 in-flight and 25 at-rest decays; $_\Lambda He^5 \rightarrow {}^4\text{He} + p + \pi^-$). Also one decay in flight and nine decays at rest of $_\Lambda He^4 \rightarrow {}^3\text{He} + p + \pi^-$ were observed in a total estimated time of 1.50×10^{-10} sec. Included in the observation times for $_\Lambda He^4$ and $_\Lambda He^5$ are contributions from nine ambiguous decays at rest of $_\Lambda He^4$ or $_\Lambda He^5 \rightarrow {}^3$He or ^{4}He $\rightarrow p + \pi^-$. (auth)

6708 ASYMPTOTIC BEHAVIOR OF THE SCATTERING AMPLITUDE AND NORMAL AND ABNORMAL SOLU-

TIONS OF THE BETHE-SALPETER EQUATION. [PART] II. Noboru Nakanishi (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 136: B1830-8(Dec. 21, 1964). (BNL-8307)

The high-energy asymptotic expansion of the Green's function for the scattering of two scalar particles in the crossed channel (t channel) is investigated in the ladder approximation by using the scalar-photon-exchange model with scalar coupling. It is shown that each term of the asymptotic expansion in the t channel exactly corresponds to the solutions of the Bethe-Salpeter equation for bound states if one considers the expansion in powers of $(-t - m^2 + v_0)$ instead of $(-t)$, where m and v_0^2 are the internal mass and the constant external mass ($v_0 \neq m^2$), respectively. It is proved that all normal solutions of the Bethe-Salpeter equation appear in this expansion. The problem of whether or not abnormal solutions also appear in this expansion is analyzed. Exact solutions in some special cases are presented and discussed. (auth)

6709 $\mu^- + He^3 \rightarrow H^3 + \nu$ CAPTURE RATE. R. J. Oakes (Stanford Univ., Calif.). Phys. Rev., 136: B1848-50(Dec. 21, 1964).

The muon capture rate in ^3He for the process $\mu^- + {}^3He \rightarrow {}^3H + \nu$ has been computed using nuclear wave functions suggested by recent analyses of e-^{3}He and e-^{3}H scattering experiments. (auth)

6710 ELECTRON-SPIN-ECHO ENVELOPE MODULATION. L. G. Rowan (Univ. of California, Berkeley), E. L. Hahn, and W. B. Mims. Phys. Rev., 137: A61-71(Jan. 4, 1965).

If an electron-spin moment is reoriented by a pulse of microwave power at magnetic resonance in a time short compared to the Larmor periods of neighboring nuclear moments in a solid, the nuclei suffer non-adiabatic changes in local dipolar field produced by the electron spin. After the pulse, a given nucleus will precess about a new axis of quantization which is appreciably tilted from its original axis if the electron dipolar field at the nuclear site has an appreciable component perpendicular to an applied external magnetic field. Consequently, a coherent oscillating nuclear dipolar field at the electron site modulates the electron Larmor frequency at the lower nuclear resonance frequencies of the nuclear neighbor. The depth of the beat modulation, as it affects the electron free-precession signal, is determined by the magnitude of electron-nuclear magnetic coupling and the extent to which the new axis of nuclear quantization is tilted from its original axis after the microwave pulse. The electron free-precession beats are measured conveniently in terms of the electron-spin-echo envelope modulation pattern obtained from the two-pulse echo experiment. The theory of the effect is developed for purely magnetically coupled nuclei and is confirmed by electron-spin-echo measurements of paramagnetic Ce^{3+} in $CaWO_4$, where the 14%-abundant ^{183}W nuclear isotope is coupled to Ce^{3+}. The electron-nuclear ligand tensor dipole-dipole interaction is estimated from experiment to be as much as four times greater than that expected from the point dipole-dipole interaction, and the ligand hyperfine interaction appears to be small. (auth)

6711 A NEW TYPE OF NUCLEAR FISSION. S. M. Polikanov and V. L. Mikheev. Priroda, No. 6, 70-3 (June 1964). (In Russian)

Fission of heavy elements by neutrons, alpha particles, gamma quanta, heavy ions, and mesons is reviewed. The concept of potential barrier in fission is discussed. The discovery of spontaneous fission is cited, and half-decay periods of heavy elements by spontaneous fission are graphed and discussed in terms of the liquid drop model. Experiments on spontaneous fission, using heavy ion bombardment of U targets to form excited nuclei, are reviewed, and the apparatus used is described. (M.J.T.)

6712 TOTAL CROSS SECTION OF ARSENIC FOR NEUTRONS IN THE ENERGY RANGE 0.05-40 ev. S. Apostolescu, M. Constantinescu, S. Dobrescu, I. Ivanceanu, and V. Mateiciuc (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 121-6(1964). (In French)

The total cross section of ^{75}As was measured with respect to 0.05 to 50 ev neutrons, by using a time-of-flight spectrometer comprised a fast chopper and a 400-channel analyzer with magnetic memory. The detector, comprising 20 proportional counters, was placed at the end of a 25.4-m path. The thickness of the spectroscopically pure As sample was 2.154 g/cm^2. The maximum resolution was 1.02 μsec/m. The total cross section was constant at a value of 8.64 ± 0.5 b over the range 1 to 40 ev, and increased slowly below 1 ev to 10 b at 0.05 ev. (auth)

6713 H^3 OR He^3 REDUCED WIDTHS ON SUPERFLUID MODEL. A. Sandulescu and Fl. Stancu (Inst. for Atomic Physics, Bucharest). Rev. Roumaine Phys., 9: 155-62 (1964).

The explicit expressions of the reduced widths for the nuclear reactions with ^{3}H or ^{3}He were obtained on the basis of the superfluid model and by using a similar procedure as for α particles. (auth)

6714 MULTIPLE MOLECULAR BEAMS. C. H. Anderson, M. Baker, and N. F. Ramsey (Harvard Univ., Cambridge, Mass.). Rev. Sci. Instr., 36: 57-8(Jan. 1965).

A multiple molecular beam technique is described in which a series of beams are used in parallel in a single apparatus to increase total beam intensity while retaining a high sensitivity to small deflections. The particular arrangement used had a single source slit and multiple collimator and detector slits arranged such that 19 beams transversed the three-meter machine, each 0.012 mm wide at the collimator and spaced 0.032 mm apart. (auth)

6715 MONOPOLE VIBRATIONS OF CLOSED SHELL NUCLEI. Hartwig Schmidt (Technische Hochschule, Munich). Z. Physik, 181: 532-41(1964).

A collective vibration in normal Fermi systems is described which represents the formation of virtual Cooper pairs and is closely connected with the phase transition from the normal to the superfluid state. Numerical results for this collective mode in ^{16}O are reported and compared with experimental data on the 6.06-Mev 0^+ level. (auth)

6716 EFFECTS OF ZERO-POINT OSCILLATIONS OF THE NUCLEAR SURFACES ON FORM FACTORS OF INELASTIC ELECTRON SCATTERING. Dieter Drechsel (Technische Hochschule, Darmstadt, Ger.). Z. Physik, 181: 542-52(1964). (In German)

The transition densities from the ground state to excited states of atomic nuclei are calculated from the drop model, taking the zero-point oscillations of the nuclear surface into account. The calculation yields transition densities smeared out over a distance of 2–3 fm near the nuclear surface. In the case of n-surfon transitions the radial dependence of these densities is proportional to the n-th derivative of the ground-state density. The numerical evaluation yields inelastic form factors quite similar to those of Crannell et al. Compared with the form factors of Walecka, the higher maxima are less distinct. (auth)

6717 NUCLEAR MAGNETIC RELAXATION AND CORRELATION IN TWO-SPIN SYSTEMS. R. Hausser and F. Noack (Technische Hochschule, Stuttgart). Z. Physik, 182: 93-110(1964). (In German)

Macroscopic relaxation phenomena of a magnetic spin system in a magnetic field are related to microscopic fluctuations and the corresponding correlations by the systematical theory of relaxation. This relation is investigated experimentally for some typical examples in the field of nuclear magnetic resonance by means of the frequency dependence of nuclear magnetic relaxation times. A short description of a pulse spectrometer which operates on 12 different frequencies from 50 kc to 160 Mc is given. From the dispersion of both T_1 and T_2 in various paramagnetic solutions, as well as in pure liquids, correlation times of the relaxation process are evaluated. The form of these dispersion curves is especially suitable for distinguishing between translational and rotational power spectra and allows for conclusions about the corresponding molecular motions. (auth)

6718 SHELL-MODEL DESCRIPTION OF THE EXCITATION OF HEAVY NUCLEI BY INELASTIC ELECTRON

SCATTERING. J. T. Reynolds and D. S. Onley (Duke Univ., Durham, N. C.). 34p. (CONF-452-66)

From American Physical Society, Washington, D. C., Apr. 1964.

The nuclear shell model with residual pairing and long-range forces is used to calculate angular distributions of inelastically scattered electrons exciting one-phonon E2, E3, and E4 transitions in spherical nuclei. The electron wave functions are treated by the distorted-wave method. Treatment of two-photon excitations by the direct (single excitation) process is also presented. Numerical results for scattering from ^{58}Ni and ^{60}Ni show good agreement with experimental cross sections for one-phonon excitations but not for two-phonon states. (auth)

6719 NUCLEAR RESONANCE FLUORESCENCE IN Te^{122}. J. C. Palathingal (Univ. of Pennsylvania, Philadelphia). 17p. (CONF-452-68)

From American Physical Society, Washington, D. C., Apr. 1964.

The mean life of the 564-kev excited state in ^{122}Te was determined by the nuclear resonance fluorescence method using a gaseous source of ^{122}Sb in the form of antimony trihydride. The value $\tau = (1.06 \pm 0.14) \times 10^{-11}$ sec was obtained for the mean life of the 564-kev state. (auth)

6720 THE DYNAMIC COLLECTIVE THEORY OF ODD A NUCLEI. Michael Danos (National Bureau of Standards, Washington, D. C.), Walter Greiner, and C. Byron Kohr. 47p. (CONF-452-70)

From American Physical Society, Washington, D. C., Apr. 1964.

The unified model and the collective giant dipole resonance model are unified. The resulting energy spectrum and the transition probabilities are derived. A new approximate selection rule involving the symmetry of the γ-vibrations is established. It is verified that the main observable features in the photon absorption cross section are not influenced by the odd particle, despite the considerably richer spectrum of states as compared to even-even nuclei. (auth)

6721 RESONANCES IN THE $S^{32,33,34}(p,\gamma)Cl^{33,34,35}$ REACTIONS WITH BOMBARDING ENERGIES IN THE ONE Mev TO TWO Mev RANGE. Anthony Kalil Hyder, Jr. (Air Univ., Wright-Patterson AFB, Ohio). 73p. (CONF-452-71)

From American Physical Society, Washington, D. C., Apr. 1964.

A search for resonances in the ^{32}S, ^{33}S, and ^{34}S (p,γ) reactions for proton energies in the one to two Mev range was conducted. Natural sulfur targets, in elemental form with a thin gold overlay, with thicknesses about 5 kev for 1.5 Mev protons, and enriched ^{33}S and ^{34}S targets, in Ag_2S compound form, with thicknesses about 1–2 kev for 1.5 Mev protons, were used. Gamma rays were detected at 55 degrees relative to the proton-beam direction. In each of the three yield curves, pulses were counted simultaneously with three scalers biased for selected gamma energies. Approximately thirty ^{34}S resonances, in addition to those listed in a review article by Endt and Van der Leun, were found in the energy region studied. The observed resonance widths were less than or equal to 2 kev, except for the $\Gamma \approx 5$ kev, $E_p = 1510$ kev resonance. In the ^{33}S yield curve, twelve prominent resonances, with widths less than or equal to 2 kev were observed in addition to others previously known. Above 1600 kev, evidence for many weak, closely spaced ^{33}S resonances was found. In the yield run made with a natural sulfur (95% ^{32}S) target, a resonance was found at $E_p = 1754$ kev which could be attributed to ^{32}S. The ^{32}S resonance at $E_p = 1900$ kev, previously reported by Lonsjo, was not observed. (auth)

6722 ANALYSIS OF LIGHT Λ-HYPERFRAGMENTS ON THE SEPARABLE POTENTIAL MODEL. PART II. G. Bhamathi and Indumathi Seshadri (Univ. of Colorado, Boulder). 26p. (CONF-452-72)

From American Physical Society, Washington, D. C., Apr. 1964.

The hyperfragments $_\Lambda H^3$ and $_\Lambda H^4$ are analyzed on the separable potential model. The interaction strength parameters in the singlet and triplet states of Λ-N interaction ($\lambda^s_{\Lambda N}$ and $\lambda^t_{\Lambda N}$) are obtained from the binding energy data of $_\Lambda H^3$ and $_\Lambda H^4$ respectively. It is found that $\lambda^t_{\Lambda N}$ is less than $\lambda^{max}_{\Lambda N}$ only on the assumption of a Λ + d + N structure for the $_\Lambda H^4$ system. The total cross sections for Λ-N scattering calculated from these parameters $\lambda^s_{\Lambda N}$ and $\lambda^t_{\Lambda N}$ are in reasonable agreement with the available experimental data. (auth)

6723 A THEORY OF ISOBARIC SPIN ANALOGUE RESONANCES. D. Robson (Florida State Univ., Tallahassee). 52p. (CONF-481-85)

From American Physical Society Annual Meeting, New York, Jan. 1964.

A theory of isobaric spin analog resonances is developed by considering a potential model which has an isobaric spin-dependent component. The occurrence of isobaric states as compound nucleus resonances is shown to be a natural consequence of the formalism previously used to explain the excitation of isobaric analog states by the direct interaction charge exchange mechanism. The results are then generalized on the basis of the R-matrix theory of nuclear reactions due to the expectation that isobaric spin is relatively pure within a sphere of dimensions similar to those of the charge distribution. The interpretation of analog resonances as giant resonances is considered and shown to be different from the conventional optical giant resonances. Formulas are derived which are mainly applicable to the elastic scattering of protons below the Coulomb barrier. The importance of the external and internal regions with respect to isobaric spin mixing is investigated for the case of ^{92}Mo(p,p)^{92}Mo, and results obtained which verify the importance of external mixing for this nucleus. Various limitations of the theory are discussed and further developments are indicated. (auth)

6724 MAGNETIC SCANNING OF ^{193}Hg. W. T. Walter (TRG Inc., Melville, N. Y.) and H. H. Stroke. 8p. (CONF-452-65)

From American Physical Society, Washington, D. C., Apr. 1964.

Magnetic scanning with the 2537-Å line was used for hfs study of several neutron-deficient mercury isotopes. Since even a perfect diffraction grating has satellites, magnetic scanning has an advantage over spectroscopic studies of weak lines close to strong lines. Scanning curves confirmed the spectroscopic measurements of isotope shift and hyperfine splittings of ^{192}Hg, ^{193m}Hg, ^{194}Hg, ^{195m}Hg, and ^{196}Hg, but not of ^{193}Hg. The ^{193}Hg F = 3/2 component is displaced farther from ^{196}Hg than spectroscopic measurements indicated. This implies an isotope shift of ^{193}Hg relative to ^{196}Hg of 213 ± 26 mK, instead of 165 ± 20 mK, and places it within the error limits of the ^{193m}Hg isotope shift (231 ± 6 mK). The staggering parameter γ is reduced to 1.16 ± 0.39 from 1.77 ± 0.43. Since a γ of 1.0 is within the error limits, the Tomlinson-Stroke explanation of odd-even staggering in isotope shift would hold for ^{193}Hg, as it does for the other odd mercury isotopes. This scanning result supports the assignment I = 1/2 for ^{193}Hg. (auth)

Plasma Physics and Thermonuclear Processes

6725 (AL-TDR-64-248) A STUDY OF THE TRANSIENT BEHAVIOR OF PLASMAS. H. J. Oskam (Minnesota. Univ., Minneapolis). Oct. 1964. Contract AF33(657)-8685. 94p. (AD-607941) $3.00 (OTS).

The dynamic properties of a plasma-boundary sheath are studied. The calculation and measurement of the capacitance value of a plasma sheath are described. The calculations predict that the capacitance value of a plasma sheath surrounding a cylindrical probe depends only weakly on the ratio of the probe radius and sheath radius. Measurements confirm this prediction and yield values in agreement with theory. (auth)

6726 (CEA-R-2456) ETUDES D'INTERACTIONS FAISCEAU-PLASMA EN LA PRESENCE D'UN CHAMP

MAGNETIQUE. (Study of Beam-Plasma Interactions in the Presence of a Magnetic Field). Claude Etievant (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Fontenay-aux-Roses). 1964. 231p. (EUR-1808.f). Dep.(mn).

Thesis submitted to Universite, Paris.

The instabilities developing in a "beam-plasma" system and in a "double-beam" system in the presence of a magnetic field are discussed theoretically starting from the conductivity tensor expression for a multi-beam system. Oblique propagation is taken into account, and this leads to the introduction of certain instability mechanisms which would not appear in the case of a propagation purely parallel or perpendicular to the magnetic field. Two experiments are described. An instability was observed experimentally in counter-streaming beams, which leads to the generation of a stationary cyclotron wave. A description is given of the measurement of the interaction frequency, of the wavelength, and of the build-up time of the wave. Studies are also made of a "beam-plasma" system. A description is given of the measurement of the spectra of excited waves and of the perturbation of the beam velocity distribution at the plasma-exit. This perturbation is very pronounced when "plasma-plasma" interaction appears in the system. A study into cyclotron oscillations produced in the plasma by excitation due to the passage of the beam is also described. (auth)

6727 (IPP-1/16) SPEKTROSKOPISCHE MESSUNG DER ELEKTRONENDICHTE UND TEMPERATUR BEIM HOHLPINCH. (Spectroscopic Measurement of Electron Density and Temperature in a Hollow Pinch). Hans Hemmerich (Institut für Plasmaphysik, G.m.b.H., Garching, Germany). Jan. 1964. 55p. Dep.(mn).

Electron density and temperature were determined spectroscopically for a hollow-pinch discharge in deuterium. For technical reasons only the integral of the radiation intensity over the total layer of the plasma hollow cylinder could be measured in a radial direction. There was good agreement from the two independent methods of measuring electron density (absolute intensity of a continuum region and Stark profile of an emission line). Theoretical principles and experimental arrangements for the spectroscopic measurements are described. Results are presented in graphs. (M.C.G.)

6728 (IPP-4/11) DIAGNOSTIC METHODS IN THE FIELD OF PLASMA PHYSICS. A. Steinhausen (Institut für Plasmaphysik, G.m.b.H., Garching, Germany). June 1964. 21p. Dep.(mn).

The basis of some essential diagnostic methods in plasma physics is treated. At first methods which are technically simple, such as electrical and probe measurements, are considered. High-speed photography, with its special requirements in plasma physics, is described. Some diagnostic instruments for density measuring, especially designed for plasma physics, such as interferometric measurements with light and microwaves, light scattering, and Faraday rotation, are explained. (auth)

6729 (IPP-6/4) ON THE SUPERKINETIC EQUATION FOR SPATIALLY-HOMOGENEOUS PLASMAS. James E. McCune (Institut für Plasmaphysik, G.m.b.H., Garching, Germany). Aug. 1963. 32p. Dep.(mn).

A derivation from the Liouville equation of the equations describing the irreversible evolution of the N-momenta distribution function for a classical, spatially homogeneous plasma is given. Collective effects are included. This "superkinetic" description reduces to the weak-coupling "master equation" when collective effects are neglected. The results are given in terms of a closed, coupled set of equations analogous to those for the kinetic description of a plasma. The origins of irreversibility in plasmas are discussed, and the properties of the stationary solutions of the superkinetic equations are analyzed. (auth)

6730 (IPP/6/7) KINETIC EQUATIONS FOR PLASMAS. PART I. Pieter P. J. M. Schram (Institut für Plasmaphysik, G.m.b.H., Garching, Germany). Sept. 1963. 61p. Dep.(mn).

A short review is given of some methods for the derivation of kinetic equations. A procedure based on the concept of multiple time scales is then followed for weakly coupled and long range homogeneous systems. The advantages of this procedure are exposed and the Landau equation is rederived in a more compact form. Results are found for relaxation into the kinetic regime and the conditions for kinetic behavior. (auth)

6731 (IPP/6/8) THE CORRELATION FUNCTION IN A PLASMA. PART III. Pieter P. J. M. Schram (Institut für Plasmaphysik, G.m.b.H., Garching, Germany). Oct. 1963. 38p. Dep.(mn).

A one-species homogeneous plasma is studied outside equilibrium. The normalization of the correlation function is discussed, leading to a condition on the Fourier transform in space of the density correlation $G(\vec{k})$ for $\vec{k} \to 0$. $G(\vec{k})$ is computed by two different methods, and the result is connected with the fluctuation spectrum of the electric field. Integrals involved in the general case are evaluated for small $|\vec{k}|$. This result introduces a limitation on the behavior of the velocity distribution for large velocities. It is shown that fluctuation spectra may be obtained also from test particle calculations. The test particle problem helps in understanding the limitation mentioned above. $G(\vec{k})$ is used to compute the interaction part of the equation of state. (auth)

6732 (IPP-6/14) ZWEIDIMENSIONALE INNEN-FELDFREIE PLASMA-KONFIGURATIONEN IM GLEICHGEWICHT MIT EINEM ÄUSSEREN MAGNETFELD. (Two-Dimensional Inner-Field-Free Plasma Configurations in Equilibrium with Outer Magnetic Field). Rudolf Gorenflo (Institut für Plasmaphysik, G.m.b.H., Garching, Germany). Jan. 1964. 50p. Dep.(mn).

The two-dimensional analog of toruslike plasma configurations without interior field is treated by function-theoretic methods. If the boundary of the doubly connected plasma domain consists of two closed analytic curves whose equations are known, the structure and the singularities (determining the currents) of the exterior magnetic field can be obtained by combining analytic continuation and conformal mapping. An example is discussed in detail. (auth)

6733 (IPP-6/15) KINETIC EQUATIONS FOR PLASMAS. PART II. Pieter P. J. M. Schram (Institut für Plasmaphysik, G.m.b.H., Garching, Germany). Feb. 1964. 35p. Dep.(mn).

The kinetic equation for a one-species homogeneous plasma in the presence of an external homogeneous magnetic field is derived with the aid of an extension method. Although collective effects are not taken into account the collision integral converges for large interaction distances, due to the fact that the Larmor radius plays the role of a natural cut-off. This is explained by considering the collision process itself in some detail. A contribution to the kinetic equation is found, exhibiting an anisotropic character, produced by the long duration of the interaction of two gyrating particles having a small relative velocity of the guiding centers. Results are obtained for the relaxation into the kinetic regime. (auth)

6734 (IPP-6/18) EXCITATION LEVEL OF PLASMA OSCILLATIONS. M. Feix (Institut für Plasmaphysik, G.m.b.H., Garching, Germany). May 1964. 29p. Dep.(mn).

In order to get insight in the phenomena of plasma oscillations, the amplitudes of the different contributions in the free oscillation problem are compared (poles due to the plasma and the initial conditions). It is found that for small k only the Landau poles are excited and they will play the dominant role at time $t = 0$ (but perhaps not indefinitely). In the problem of forced oscillations by a macroscopic electric field it is also found that the Landau solutions are dominant near the plasma frequency. Finally the behavior of the transient cloud around an initially correlationless test particle is shown to be dominated by the waves with a group velocity equal to the test particle velocity. (auth)

6735 (IPP-6/21) LICHTSTREUUNG UND MISCHUNG IN EINEM PLASMA. (Linearisierte Theorie). (Light Scattering and Mixing in a Plasma. (Linearized Theory)). Wilhelm H. Kegel (Institut für Plasmaphysik, G.m.b.H., Garching, Germany). July 1964. 102p. Dep.(mn).

The theory of light scattering in a plasma is reviewed. A scattering formula is derived, which connects the scattered intensity to the fluctuations of the electron density in the plasma. At first the time mean of the density fluctuations is considered. This quantity corresponds to the total energy scattered into a given solid angle. The spectral distribution is derived from the linearized Vlasov equation. The results are discussed from the viewpoint of determining plasma parameters by means of light scattering experiments. The theory is extended to the case of an external electric field. For a plasma with an external magnetic field it is shown that density fluctuations can be forced by an external electric field (laser beam). If light of a second beam is scattered at these fluctuations, light mixing occurs. An essential condition for this effect is that the two light beams have to be parallel. This theory includes also the generation of the second harmonic. The limitations of the outlined theory are discussed. (auth)

6736 (IPP-6/26) THE HARMONICS OF THE ELECTRON CYCLOTRON FREQUENCY IN PLASMAS. E. Canobbio and R. Croci (Institut für Plasmaphysik, G.m.b.H., Garching, Germany). Sept. 1964. 46p. Dep.(mn).

The problem of the harmonics of the electron cyclotron frequency in plasmas is discussed. The dispersion relation for propagation vectors nearly perpendicular to the external magnetic field is studied for some density, temperature, and frequency ranges. The unperturbed distribution function is assumed to be Maxwellian. Longitudinal waves are also discussed in plasmas with electron streams and temperature anisotropies. (auth)

6737 (NASA-TR-R-212) THEORETICAL ANALYSIS OF SEVERAL LINEAR STEADY-FLOW PLASMA ACCELERATORS WITH CROSSED ELECTRIC AND MAGNETIC FIELDS. Clarence W. Matthews (National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.). Dec. 1964. 52p. $1.50(OTS).

The ideal one-dimensional equations that express the motion of an inviscid, compressible, conducting, single-fluid plasma through crossed electric and magnetic fields are written in a nondimensional form. Solutions of these equations are then presented for conditions wherein the cross-sectional area is held constant or is allowed to vary in such a way that the velocity, pressure, or density is held constant. These conditions are considered for a number of variations of the current density with velocity. Several special cases are also presented in which the velocity, pressure, temperature, or Mach number is held constant in a constant-area channel. For illustrative purposes computed results are presented for most of the solutions. These results are used to show the nature of the various modes of channel operation and may be used to compare modes and to make a preliminary selection of the mode of operation required to achieve a given purpose. These computations show whether a channel will accelerate or decelerate the flow, whether the flow is regular or forbidden, whether the velocity is limited or unlimited as the channel length becomes infinite, or whether other unexpected peculiarities exist. (auth)

6738 (RLE-TR-426) EXCITATION OF ION OSCILLATIONS IN BEAM-PLASMA SYSTEMS. M. T. Vlaardingerbroek (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics). July 23, 1964. Contract DA-36-039-AMC-03200(E). 34p. (AD-607269) $2.00 (OTS).

This report suggests possible ways for theoretical study of the interaction of an electron beam and the ions in a hot-electron plasma. Equations are obtained for the beam-plasma interaction in a filled cylindrical waveguide in which the thermal velocity distribution is longitudinal but otherwise arbitrary. An approximation based on these equations by using only one transverse wave number is described. A close resemblance is found between the approximate solutions and the theory of plane waves in an infinite beam-plasma system, traveling at an angle with the direction of the beam and the magnetic field and having a certain fixed real transverse wave number. This resemblance is used to calculate beam- (hot-electron) plasma interaction including a transverse random velocity distribution. Theories of a filamentary beam and a plasma-filled waveguide are combined, using the coupling-of-modes theory, for the description of some of the weak interactions between a thin beam and a finite plasma. (auth)

6739 (UCRL-Trans-1132(L)) STUDY OF JOULE HEATING OF PLASMA IN TOROIDAL TOKAMAK INSTALLATIONS. L. A. Artsimovich, Te. P. Gorbunov, S. V. Mirnov, V. S. Mukhovatov, K. A. Razumova, and V. S. Strelkov (U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii. Institut Atomnoi Energii Im. I. V. Kurchatova, Moscow). Translated by T. Watt (Univ. of California Lawrence Radiation Lab., Livermore), 1964. 79p. Dep.(mn); $3.00(cy) 2(mn) OTS; $7.60(fs), $2.57(mf) JCL.

Results are reported of a theoretical analysis of the heating process, the conditions of equilibrium, and the stability of plasma loops in toroidal Tokamak installations. A description is given of the installations and of the diagnostic methods in use. Recent physical measurements are discussed. It is shown that the macroscopic characteristics of the discharge are very dependent on the transverse control magnetic field and on the magnitude of the longitudinal magnetic field. A magnetohydrodynamically stable plasma filament was obtained under optimum discharge conditions, with an electrical conductivity reaching 2×10^{16} esu ($T_e \sim 150$ ev). The experimentally determined lifetime of charged particles is compared with the theoretical value which one would expect in the presence of Bohm or classical diffusion. The possibilities of the Joule heating of plasma in Tokamak installations are discussed. (auth)

6740 ORTHOGONALITY PROPERTIES OF MODES IN A COMPRESSIBLE PARTIALLY IONIZED PLASMA. S. N. Samaddar (Raytheon Co., Wayland, Mass.) Appl. Sci. Res., Sect. B, 11: 84-102(1964).

Linearized hydrodynamic equations together with Maxwell's equations are used to describe a compressible partially ionized plasma interacting with a weak electromagnetic field. Using this fluid description of a plasma, orthogonality properties of modes are investigated for a compressible, partially ionized plasma. This plasma is confined in a uniform cylindrical structure of arbitrary cross section, in the presence or absence of a static magnetic field along the axial direction. The modes in the plasma are found to be orthogonal provided they satisfy the following conditions: the electromagnetic field must satisfy the usual known impedance boundary conditions, and the pressure is proportional to the normal component of the velocity of the fluid elements (i.e., plasma elements) at the boundary in a particular way which may be termed the hydrodynamic impedance boundary condition. (auth)

6741 MAGNETOHYDRODYNAMIC GENERATOR MEASUREMENTS IN ARGON AND HELIUM PLASMAS. A. G. Bailey (Univ. of Sheffield, Eng.). Brit. J. Appl. Phys., 15: 1399-1407(Nov. 1964).

Using an electrically driven shock tube as a plasma source, measurements of plasma conductivity were made using two cold tungsten probes and a magnetohydrodynamic interaction. Complete load characteristics for the generator system were determined and from these conductivity values were estimated. The measurements in argon with a transverse magnetic field of 3100 gauss were as expected yielding conductivity values of the same order as the ionic conductivity predicted theoretically. In the cases of helium for applied magnetic fields of 3100, 5500, and 7500 gauss, and argon for the two higher field values, the conductivity values for low values of probe current corresponded to the expected ionic conductivities. At a particular current there was an abrupt change of conductivity which for even greater currents remained con-

stant and was of the same order as the theoretical estimates of electronic conductivity. (auth)

6742 THEORY OF THE "DYNAMIC PLUG" WITH STATIC MAGNETIC AND HIGH-FREQUENCY FIELD GRADIENTS. René Bardet, Terenzio Consoli, and Richard Geller (CEN, Saclay, France). Compt. Rend., 259: 2388-91(Oct. 12, 1964). (In French)

The theory is presented of the reflection of a plasma beam in which the electrons have a helicoidal motion with high transverse velocity and the ions have uniquely axial velocity equal to that of the electrons. (tr-auth)

6743 STABILITY OF MAGNETIC TRAP FOR A PLASMA OF FINITE PRESSURE. Jean Andréoletti (Euratom-CEA, Fontenay-aux-Roses, France). Compt. Rend., 259: 2392-5(Oct. 12, 1964). (In French)

At the limit of a weak anisotropy, the effects of the curvature of the magnetic lines and, consequently, the effects of the transverse depth of a magnetic well on the stability were shown previously. In the same form, the effects of the curvature and that of the anisotropy, which are bound respectively to the transverse depth of the traps and to its longitudinal depth, are made apparent. (tr-auth)

6744 PROPAGATION OF ELECTROMAGNETIC WAVES IN HOT MAGNETOACTIVE PLASMA. J. Musil (Inst. of Plasma Physics, Prague). Czech. J. Phys., 14: 831-47(1964).

The general form is found for the tensor of dielectric permittivity, $\epsilon_{ij}(\omega, k)$, of non-relativistic hot magnetoactive collisionless plasma taking into consideration the influence of spatial dispersion. The general form is used to express the tensor in the region of weak and strong spatial dispersion, and in some special cases. A general dispersion equation is derived, and an analysis is made of the waves propagating in hot magnetoactive plasma. The expressions derived are used to investigate the damping of a right-handed circularly polarized wave propagating in hot magnetoactive plasma in the direction of the magnetic field. (auth)

6745 PLASMA CHEMISTRY. C. P. Beguin, A. S. Kanaan, and J. L. Margrave (Rice Univ., Houston, Tex.). Endeavour, 23: 55-60(May 1964).

The design of torches operating at temperatures as high as 50,000°C, the reactions they have made practicable, and their possible future industrial applications in a number of fields are discussed. The d-c plasma jet torch is a modification of the Gerdien and Lotz arc. It is cylindrical in shape and one electrode is in the form of a conductive plate with a central hole at one end of the cylinder. The other electrode is a conductive rod that lies along the cylindrical axis and is held in position by an insulating plate at the other end of the cylinder. A gas is injected tangentially and forms a vortex in the chamber. When the arc burns, the hot gases emerge through the orifice and take away any energy not already lost to the water-cooled walls of the torch. The d-c plasma torches produce gas streams with temperatures between 8000 and 50,000°C and velocities between subsonic and Mach 20, at power inputs between 0.5 and 3000 kw. They are used for welding, cutting spheroidizing, and spraying metals, for the simulation of re-entry conditions in space research, and for chemical syntheses. The radiofrequency (r-f) plasma torch consists of a stream of ionized gas, contained in a circular quartz pipe, heated by induction, a process essentially analogous to the induction heating of a metallic cylinder. Since there are no electrodes in the r-f plasma torch, it is possible to work with reactive gases, such as oxygen and air, that would erode the electrodes of a d-c plasma torch at high temperatures. The only cooling necessary is on the outside wall. The most powerful r-f torch in use is heated with a 200-kw induction heater and frequencies in the 1 to 25 Mc/sec range were used. Axial temperatures of about 16,000°C were reported for an argon r-f plasma. Current research in the arc synthesis of compounds, such as the preparation of acetylene and the fluorocarbons, nitrogen fixation, and the reduction of metal ores is reviewed. Future applications of plasma torches are also considered. Compared with conventional heating devices, both r-f and d-c plasma torches are bound to present several advantages, which are enumerated. (BBB)

6746 FIZIKA PLAZMY I PROBLEMY UPRAVLYAEMOGO TERMOYADERNOGO SINTEZA. (DOKLADY TRET'EI KONFERENTSII PO FIZIKE PLAZMY I PROBLEMAM UPRAVLYAMEMOGO TERMOYADERNOGO SINTEZA). VYPUSK 3. (Physics of Plasma and Problems of Controlled Thermonuclear Fusion. (Report of the Third Conference on Physics of Plasma and Problems of Controlled Thermonuclear Fusion). Issue 3. K. D. Sinel'nikov, ed. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 1-367(1963). Kiev, Publishing House of Ukrainian Academy of Sciences, 1963.

The topics include high-frequency properties of plasma, beam interactions with plasma, plasma stability, magnetic traps, plasmoid diagnostics, plasma injection into magnetic traps, plasma diffusion, and methods for determining magnetic field intensities. Separate abstracts are prepared for 40 of the 43 papers presented. Abstracts of three papers previously appeared in NSA 17: 19471, 22730, and 42133. (C.E.S.)

For abstracts of individual papers see: 6398, 6418, 6445, 6446, 6747, 6748, 6749, 6750, 6751, 6752, 6753, 6754, 6755, 6756, 6757, 6758, 6759, 6760, 6761, 6762, 6763, 6764, 6765, 6766, 6767, 6768, 6769, 6770, 6771, 6772, 6773, 6774, 6775, 6776, 6777, 6778, 6779, 6780, 6781, and 6782.

6747 INVESTIGATION OF PLASMA OSCILLATIONS IN QUASIHYDRODYNAMIC APPROXIMATION. A. B. Kitsenko and K. N. Stepanov. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 3-17(1963). (In Russian)

The longitudinal oscillations of a plasma with nonisotropic distribution function, and the excitation of magnetohydrodynamic waves in interpenetrating plasma streams with nonisotropic particle velocity distribution functions are considered on the basis of the quasihydrodynamic equations. It is confirmed on the basis of these equations that one-dimensional Langmuir oscillations of an electron gas can be regarded as adiabatic with an adiabatic exponent $\gamma = 3$. The effects of the ions on both high- and low-frequency oscillations are considered. It is shown that anomalous dispersion occurs in both frequencies. In a plasma consisting of two species of ions, plasma resonance in the region of both high and low frequencies has the same distinguishing features, namely the limitation of the growth of the refractive index because of the presence of thermal motion of the plasma particles, and the appearance of a new branch of oscillations (plasma waves) with anomalous dispersion properties. An experimental investigation of the propagation of radio waves through a plasma at resonance makes it possible to determine several important characteristics of the plasma. The excitation of magnetohydrodynamic waves when streams of charged particles pass through a plasma is of particular interest in connection with the interaction between solar corpuscular streams in the upper ionosphere, for the plasma instability arising in the case of such a stream can lead to variations of the field and to the appearance of ultralow frequency radiation. (JPRS)

6748 EMISSION OF LOW-FREQUENCY WAVES BY IONS AND ELECTRONS IN MAGNETOACTIVE PLASMA. V. I. Pakhomov and K. N. Stepanov. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 17-36(1963). (In Russian)

Cyclotron radiation of ions having a velocity of the order of the average thermal velocity of the plasma ions is considered. In addition, the Cherenkov radiation of electrons in the low-frequency region is considered. The intensity of radiation is determined with allowance for cyclotron absorption of the emitted waves by the plasma ions and the Cherenkov absorption by the plasma electrons. The radiating and absorbing ability of the plasma and the equilibrium intensity of radiation in these frequency regions

are also determined. The expressions obtained for the intensity of radiation of an individual particle can be used also to estimate the intensity of radiation of charged-particle plasmoids moving through a plasma. If the plasma dimensions are smaller than the radiated wavelength, then the intensity of radiation becomes proportional to the square of the number of particles in the plasmoid (coherent radiation of the plasmoid). In the case of low frequencies, which is considered, the wavelength is large and therefore the radiation can be coherent even at relatively large plasmoid dimensions. (JPRS)

6749 HIGH-FREQUENCY PLASMA OSCILLATIONS IN A MAGNETIC FIELD. V. D. Fedorchenko, V. I. Muratov, and B. N. Rutkevich. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 36-44 (1963). (In Russian)

Oscillations in electron beams in a longitudinal magnetic field are investigated. The strong magnetic field suppresses the low frequency oscillations and increases the amplitude of the high-frequency oscillations. The spectrum of the high-frequency oscillations was plotted with the aid of a moving electric probe, the output of which was fed to a noise meter. The oscillations had a maximum in the frequency range 25–50 megacycles, the position and height of which depended on the beam energy (for a fixed current), on the magnetic field, and on the pressure in the chamber. It was also found that an optimal pressure exists at which the amplitude of the oscillations is the largest, and that the optimum value of the pressure depends on the beam energy. The oscillation frequency depends also on the beam energy and the maximum of the spectrum shifts towards higher frequencies with increasing energy. An increase in the amplitude of the ion oscillations leads to the suppression of the electron oscillations, whereas ion oscillations become more intense with increasing amplitude of the electron oscillations. Plots of the following are included: characteristic spectrum of electron oscillations, spectra of high-frequency oscillations at different pressures, spectra at different electron-beam energies, spectra at high-frequency oscillations at different magnetic fields, amplitude of high-frequency signal as a function of the probe position, role of secondary emission from the collector amplification of external high-frequency signal applied to the modulating electrode, amplification of external signal at different pressures, amplification of external signal at different magnetic fields, dependence of the amplitude of the high-frequency ion oscillations on the frequency of the external electric field enclosing the ion beam, and dependence of the amplitude of the high-frequency electron oscillations on the frequency of the external alternating electric field for air and for krypton. (JPRS)

6750 INVESTIGATION OF HIGH-FREQUENCY PLASMA OSCILLATIONS BY MEANS OF PROBING BEAM. V. D. Fedorchenko, V. I. Muratov, and B. N. Rutkevich. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 44-54(1963). (In Russian)

This is a continuation of earlier work and is aimed at measurements of the phase velocity by the method of a probing beam which passes through the main plasma beam and enters an analyzer with a retarding potential. The plasma tested constituted a hollow electron beam 50 cm long and 2 cm in diameter, with an energy that ranged from 200 to 300 volts at 25–50 milliamperes. The working pressure was 1.3×10^{-3}–1.3×10^{-4} n/m^2. The probing beam (1 mm dia, 10–15 μamp, and 0–400 v) traveled on the beam axis in the injection direction. The potential was measured with the aid of an incandescent probe inserted inside the hollow beam through a break in its annular section. The experiments with the probing electron beam indicate the existence in the plasma of considerable oscillations which modify both the main beam and the plasma. The plasma electrons become accelerated by the high-frequency field of the wave produced in the beam-plasma system, and this causes electrons to escape through the ends of the system. The escape of the electrons should be accompanied by an increase in potential in the space occupied by the plasma. However, the situation is complicated by the existence of transverse ion oscillations which cause the ions to move away to the cylindrical surface of the chamber. It is concluded that the plasma oscillations cause formation of an uncompensated charge, the polarity of which depends on which of the processes predominates, the drift of the ions due to the low-frequency transverse oscillations or the drift of the electrons due to their interaction with the longitudinal high-frequency wave. In strong magnetic fields the ion oscillations are suppressed and the longitudinal high-frequency oscillations become predominant. It is therefore to be expected that in a trap in which electrons are injected in sufficiently strong magnetic fields the plasma will have a positive potential. (JPRS)

6751 NONLINEAR EFFECTS IN PROPAGATION OF SLOW ELECTROMAGNETIC WAVES IN PLASMA WAVEGUIDE. B. I. Ivanov. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 54-64(1963). (In Russian)

Nonlinearities in a collisionless plasma are investigated for the case when the velocity of the wave is nearly equal to the plasma electron velocity. A theoretical analysis of this question was given by Ya. B. Faynberg. In the experimental setup a plasma pinch detached from the walls was produced by a d-c discharge in a longitudinal magnetic field. The high-frequency signal is applied to the discharge anode or to short coils wound around the discharge tube. The experiments were made at low frequency where the nonlinear effects increase with decreasing frequency of the signal propagating in the plasma. The apparatus and the measurement parameters are described briefly. The investigation covered the influence of nonlinear distortions of the waveform of a sinusoidal signal propagating in a plasma waveguide, the propagation of several sinusoidal signals, the determination of the plasma density, the determination of relatively small phase shifts (from which the plasma density was determined), the determination of the phase velocity of propagation of the wave in the plasma waveguide, and the determination of the spectral composition of the signal. The extent to which other nonlinearity mechanisms can influence the result is also discussed. (JPRS)

6752 SPACE CORRELATION OF FLUCTUATING ELECTROMAGNETIC FIELDS IN PLASMA. V. F. Aleksin and K. N. Stepanov. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 64-81(1963). (In Russian)

Spatial correlation functions are obtained for electromagnetic fields in anisotropic gyrotropic media (magnetoactive plasma) in the cases when the effects due to the spatial dispersion of the medium are small. It is shown that in the transparency region, when the damping is small, the correlation radius coincides with the attenuation length of the electromagnetic wave. General expressions are first derived for the correlation functions, after which spatial correlation functions are obtained for large distances. The correlation functions for high frequency (electron) oscillations are investigated, as are the spatial correlation functions in the low-frequency region. (JPRS)

6753 ON THE THEORY OF ELECTROMAGNETIC WAVE REFLECTION FROM PLASMA. I. A. Akhiezer. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 81-91(1963). (In Russian)

Unlike the customary theoretical analysis of incoherent reflection of electromagnetic waves from a plasma, where the analysis is limited to the solution of the problem of the scattering by an infinite plasma, the coefficient of incoherent reflection of electromagnetic waves from the plasma is determined with allowance for the boundary. Allowance is made for the plasma fluctuations which cause the reflection angle and the frequency of the reflected waves to differ from the incidence angle and the frequency of the incident wave. In the case of sufficiently small damping of the incident or reflected wave (but not necessarily both), the spectrum of the reflected radiation consists of the Doppler

broadening of the fundamental line and sharp peaks connected with the possibility of the propagation of collective oscillations in the plasma (Langmuir oscillations, and in the case of strong non-isothermy also sound oscillations). Conditions are obtained under which the coefficient of reflection of the electromagnetic waves from the plasma coincides (apart from a normalization factor) with the scattering coefficient in an unbounded plasma. Allowance for the plasma boundary leads to an appreciable difference between the reflection coefficient and the scattering coefficient if the frequency of the incident or reflected wave is equal in order of magnitude to the plasma frequency, and also for all frequencies in the case of glancing incidence or reflection. (JPRS)

6754 ON THE NONLINEAR THEORY OF ION CYCLOTRON RESONANCE. A. N. Kondratenko. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 91-6(1963). (In Russian)

The nonlinear theory of ion cyclotron resonance is analyzed in view of the proposed possibility of using ion cyclotron resonance to heat the ion component of a plasma situated in a waveguide in a constant magnetic field parallel to the longitudinal axis. The nonlinear part of the hydrodynamic system of equations near ion cyclotron resonance is separated, and the resultant nonlinear system of equations is solved by assuming the nonlinearity to be small. A cubic equation is obtained for the determination of the ion velocity from which the maximum ion velocity and the maximum energy which the ion can acquire are determined. In a field of 10^4 v/m^2 and 10^6 A/m, the maximum energy is on the order of several kev on the waveguide axis. (JPRS)

6755 ABSORPTION OF HIGH FREQUENCY ENERGY BY PLASMA NEAR ION CYCLOTRON RESONANCE. [PART] I. M. P. Vasil'ev, L. I. Grigor'eva, V. V. Dolgopolov, B. I. Smerdov, K. N. Stepanov, and V. V. Chechkin. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 96-109(1963). (In Russian)

Cyclotron absorption of electromagnetic waves excited by current flowing in a coil surrounding a plasma cylinder are considered. The heating of a plasma by cyclotron excitation of strongly damped (ordinary) and weakly damped (extraordinary) waves is discussed. General expressions are derived for the power absorbed by the plasma (for the energy flux inside the plasma per unit length of the plasma cylinder). Since the general expressions are rather complicated, a few limiting cases are considered, namely when the wave frequency is close to the ion cyclotron frequency, high ion-gas temperature, long-wave oscillations, and short-wave oscillations. The case of a low density plasma is also considered. Other topics touched upon are the influence of collisions on the heating of the plasma, the excitation of weakly damped (extraordinary) waves in a plasma cylinder, and the heating of a plasma consisting of a mixture of two species of ions (such as deuterium and tritium). (JPRS)

6756 ABSORPTION OF HIGH-FREQUENCY ENERGY BY PLASMA NEAR ION CYCLOTRON RESONANCE. PART II. M. V. Brzhechko, M. P. Vasil'ev, L. I. Grigor'eva, V. V. Dolgopolov, A. S. Loginov, O. S. Pavlichenko, B. I. Smerdov, K. N. Stepanov, and V. V. Checkin. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 109-17(1963). (In Russian)

An experimental check is made on the absorption of high-frequency energy by a plasma under conditions of ion cyclotron resonance, and a check on the previous theoretical deductions. The system used to feed the high-frequency power into the plasma is an artificial LC line fed at a high harmonic. This system is claimed to have several advantages over others. The source of high-frequency power was a self oscillator specially developed for the excitation of the line. The plasma was produced by a pulsed Penning discharge in a magnetic field in hydrogen. Considerable loading of the generator by the plasma took place near ion cyclotron resonance, accompanied by an increased intensity of the glow of the H_β line in the discharge. The shift in the maxima of the load curve away from the resonant value of the magnetic field, and also the form of this curve, are in agreement with the theoretical results. (JPRS)

6757 INTRODUCTION OF HIGH-FREQUENCY ENERGY INTO PLASMA LOCATED IN A METALLIC CHAMBER. O. M. Shvets, V. F. Tarasenko, S. S. Ovchinnikov, and V. T. Tolok. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 117-24(1963). (In Russian)

The possibility of feeding high-frequency power to a plasma contained in a metal chamber and the behavior of the plasma under the influence of this power were investigated. It is possible to obtain in such a chamber a rotating plasma in crossed electric and magnetic fields, with high density, high degree of ionization, sufficiently long confinement time, but low ion temperature. The first stage of the experiments, which were carried out without reconditioning the plasma in the working volume, are described. A coaxial geometry was used and 3.3-Mc power was applied either through a blocking capacitor or without one. It was found that much more power can be fed to the plasma without a capacitor. The experiments showed that high-power high-frequency generators can be used to produce a dense plasma in a metal chamber at relatively low voltages. The densities attained were 1.2×10^8 cm^{-3} at a generator voltage of 205 v, and 1.7×10^8 cm^{-3} at 220 v. A low load impedance can be attained by preconditioning the plasma. The high-frequency power can be readily used for effective generation of waves to heat the plasma. If the generator frequency is lower than the ion cyclotron frequency, the high-frequency generator can be used to produce a rotating plasma more effectively than in crossed electric and magnetic fields (using a radial capacitor discharge), since no arc is produced to contaminate the plasma with wall-chamber material. Plots showing the relations between the different plasma parameters are included. (JPRS)

6758 INTERACTIONS OF PULSED HIGH-CURRENT ELECTRON BEAMS WITH PLASMA IN A MAGNETIC FIELD. A. K. Berezin, G. P. Berezina, L. I. Bolotin, Yu. M. Lyapkalo, and Ya. B. Fainberg. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 125-38(1963). (In Russian)

The investigation was aimed at determining the energy losses of a beam passing through a plasma, the conditions under which oscillations are excited, the frequency spectrum, the amplification coefficients, the character of instability, and comparison of the experimental data with theory. The electron beam had an approximate energy 15 kev and a current 5–8.5 amp. It was injected into a quartz and glass plasma chamber, ionizing the air in it, producing a plasma, and interacting with the latter. After passing through the plasma the beam was electrostatically analyzed. The procedures used to measure the various parameters are described. The experiments showed that the beam loses an appreciable part of its initial energy (~18%). This energy is consumed in excitation of oscillations and heating the plasma. Some 50–60% of the energy loss goes to excitation of longitudinal space-charge density waves and transverse electromagnetic oscillations; this agrees qualitatively with theory. It follows from the measurements that the amplification coefficients and the maximum resonant frequency are also in satisfactory agreement with the calculated data. The longitudinal space-charge density waves excited in the plasma and in the beam have phase velocities which are smaller than the velocity of light in vacuum, and have intensities which reach 50–60 kv/m at the end of the interaction region. A small group of the electrons (1–4% of the total current) experiences an increase in energy up to 50%. If the electron beam is initially modulated, its frequency experiences a Doppler shift at the end of the interaction. (JPRS)

6759 ON THE KINETIC INSTABILITY OF PLASMA. A. I. Akhiezer, G. Ya. Lyubarskii, and R. V. Polovin. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 151-60(1963). (In Russian)

The stability of the distribution function of particles in a plasma with respect to plasma oscillations is discussed. The general conditions for the stability of the electron distribution function are derived by investigating the behavior of individual spatial Fourier components of the potential and the deviations of the electron distribution function from the initial distribution function. The first part of the analysis is devoted to a free plasma without external fields. The singular points of the Laplace transformations of the potential and of the distribution function (which determine the behavior of these functions in the steady state) are then determined. Stability criteria based on the locations of these roots in the complex plane are then established. It is shown that a distribution function which has only one maximum is stable; this confirms deductions made by others. Furthermore, an arbitrary spherically symmetrical distribution function which does not vanish anywhere is also stable, regardless of the number of maxima. The second part of the analysis is devoted to a plasma in a constant and homogeneous magnetic field, the stability being investigated only with respect to plasma waves for which the electric field is potential. The necessary and sufficient stability criteria are established, and it is shown that an even distribution function with a single maximum is stable and that any anisotropic distribution function is stable. The stability conditions for a fixed value of the plasma frequency are also established. The stability condition of the distribution function in a plasma in a constant and homogeneous weak electric field is then determined and it is shown that a weak electric field does not change the stability conditions. (JPRS)

6760 ON THE STABILITY OF HIGH-FREQUENCY HEATING OF PLASMA. V. I. Kurilko and V. I. Miroshnichenko. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 161-4(1963). (In Russian)

The stability of an ion cyclotron wave in a plasma is considered, with the analysis limited to a wave propagating along constant magnetic fields. From the dispersion equation for the longitudinal plasma oscillations transverse to the magnetic field, excited by an ion beam, it is found by a kinetic analysis that high-frequency instabilities occur in such a plasma, and the growth increments are determined. In addition, instabilities with characteristic times which are much longer than the period of the high-frequency wave can be developed during propagation of an ion cyclotron wave in the plasma. The growth increment for such instabilities is also determined. (JPRS)

6761 INSTABILITY OF CYCLOTRON METHOD FOR PLASMA HEATING. N. I. Nazarov, A. I. Ermakov, V. T. Tolok, and K. D. Sinel'nikov. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 164-8 (1963). (In Russian)

To clarify the question of the effectiveness of plasma heating by ion cyclotron waves and to study the influence of the level of the high-frequency power on the plasma heating in the ion gyroresonance region, an experiment was performed. The results of the tests indicate that there exist two distinctly different modes of plasma behavior, one in which the plasma exists for a relatively long time, and one in which the plasma begins to decay even before the termination of the high-frequency power pulse. A radical decrease in the lifetime of the plasma occurs at a definite critical power level supplied to the plasma, and the smaller the pressure the smaller the critical power. The critical power depends on the cleanliness of the system and increases for a poorly preconditioned system. This dependence on the pressure and on the purity of the system suggests that the observed instability is due to the appearance of ion currents with large directional velocities. At the present time the nature of the observed instability cannot be reconciled with the existing theory. (JPRS)

6762 EVOLUTION CONDITIONS IN ORDINARY AND MAGNETIC HYDRODYNAMICS. R. V. Polovin. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 169-79(1963). (In Russian)

The relation between the stability of various plasma configurations and the conditions for the existence of solutions of the corresponding equations are reviewed, and cases when stability investigations are best replaced by evolutionality considerations are illustrated. The investigation of evolutionality is simpler than the investigation of ordinary stability, since it reduces to a calculation of the number of outgoing waves and permits one to ascertain from a single point of view the absence of many solutions of ordinary hydrodynamics and to predict the absence of many solutions in magnetohydrodynamics. In particular, without the use of evolutionality conditions it is impossible to solve magnetohydrodynamic problems in the presence of shock waves. Many known relations in hydrodynamics and magnetohydrodynamics are then corroborated with the aid of the evolutionality conditions. (JPRS)

6763 THERMODYNAMIC RELATIONS IN PLASMA. R. V. Polovin and K. P. Cherkasova. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 179-83(1963). (In Russian)

The behavior of a plasma consisting of several species of charged and neutral particles is described by means of the hydrodynamic equations of motion of each of the components to which are added the continuity equation, Maxwell's equations, and the energy balance equation. A derivation, based on the second law of thermodynamics, of the change in entropy of each component, the internal change in the entropy per unit volume of the plasma, and the quantity of heat released per unit volume and per unit time is presented. Kinetic effects are neglected. The expression for the quantity of heat includes the heat flux carried together with the particle, the heat released because of thermal conductivity, the heating collisions, and the thermoelectric effects. (JPRS)

6764 INVESTIGATION OF PLASMA PROPERTIES IN CROSSED ELECTRIC AND MAGNETIC FIELDS. O. M. Shvets, S. S. Ovchinnikov, V. F. Tarasenko, and V. T. Tolok. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 184-92(1963). (In Russian)

Tests were made on a rotating plasma in crossed fields, confined by a system of magnetic mirrors. The installation constitutes a coaxial copper chamber (inside and outside diameters 1.6 and 12.5 cm respectively, length 180 cm) placed in a homogeneous magnetic field that can be regulated from 0 to 20 A/m and in a radial electric field produced by capacitor bank of 1050 μF connected to the system through a discharge gap and six coaxial cables. The vacuum in the system was 1.33×10^{-4} n/m^2. Oscillograms were taken of the waveform of the plasma voltage, of the capacitor and short-circuit currents, of plasma-diamagnetism signals from a probe located in the working volume, and of the time dependence of the light, obtained with a photomultiplier. The results show that a plasma rotating in crossed electric and magnetic fields has many advantages over a plasma produced by other means. A rotating plasma can be retained for several hundred microseconds at densities on the order of 10^{15} cm^{-3} and high degree of ionization (~30%). The confinement time (650–1000 μsec) agrees well with the time of penetration of the magnetic field due to the azimuthal current through the chamber wall (~1000 μsec). It is therefore proposed that the plasma confinement time is determined under these conditions essentially by the time of penetration of the magnetic field through the chamber wall. If this factor turns out to be decisive, then the penetration time of the field can be increased by increasing the wall conductivity and the wall thickness. The former can be done by cooling the chamber, but the latter entails attenuation of the field at the chamber walls. Experiments are continuing in this direction since an estimate indicates that the penetration time of the magnetic field through the chamber wall can be increased by three orders of magnitude. (JPRS)

6765 MOTION OF ELECTRONS IN CROSSED ELECTRIC AND SPACE-MODULATED MAGNETIC FIELDS. V. G. Marinin. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 192-8(1963). (In Russian)

In order to ascertain the influence of the electric field present in the system on the interaction between particles and a spatially modulated magnetic field, the equation of motion of an electron in the right-hand-cylindrical system of coordinates was solved, and the results were checked experimentally. The equipment consisted of a vacuum chamber (tube 4 cm in diameter and 120 cm long) pumped out to $0.7 \times 10^{-3} - 0.133 \times 10^{-2}$ n/m^2. A homogeneous magnetic field was produced by a long solenoid placed over the tube, and a system of coils connected to buck each other produces a periodic magnetic field of period 4.8 cm (total number of periods – 5). The experiments showed that when the electrons move in crossed electric and spatially modulated magnetic fields, the resonant interaction between the electrons and the spatially modulated magnetic field occurs for a different relation between the longitudinal electron velocity, the cyclotron frequency, and the period of spatial modulation than in the case when there is no radial electric field. This indicates that the presence of a negative potential in the system does not cause the electrons to go out of resonance, in spite of the decrease in the longitudinal velocity. (JPRS)

6766 THE Θ PINCH PLASMA IN MAGNETIC NET. Ya. F. Volkov, V. T. Tolok, and S. M. Krivoruchko. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 199-206(1963). (In Russian)

Experiments were set up to ascertain the confining ability of a magnetic grid without a longitudinal field, where the plasma is injected from the ends of the chamber. Another purpose of the experiment was to compare the stability and cleanliness of a Θ-pinch plasma with a peripheral field and without it. The experimental setup and the procedure are described. Measurement of the lifetime of the plasma with density above 6×10^{13} cm^{-3}, and of the intensity of the peripheral field B_φ between neighboring conductors at zero longitudinal field, made at a constant pressure of 13.3 n/m^2, has shown that the confinement time increases from 20 to 70 microseconds as the field is increased from 0.5 to 24×10^4 A/m. The existence is proportional to $B_\varphi^{\frac{1}{2}}$. Superposition of the field of the magnetic grid on the Θ pinch apparently decreases the instability; the particles are lost predominantly through the magnetic gaps. The amount of impurity (from the walls) in the discharge decreases with increasing B_φ, and the amount of absorbed hydrogen released from the walls also increases. It is pointed out that the results of these experiments are still preliminary, in view of the small diameter of the chamber and the small values of the magnetic field. (JPRS)

6767 EXPERIMENTS FOR CONFINING PLASMA BY FAST GROWING MAGNETIC FIELD. G. G. Aseev, V. S. Voitsenya, and V. G. Konovalov. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 206-11(1963). (In Russian)

Experiments were set up to ascertain the causes of the slow displacement of a compressed plasma pinch from the system axis towards the wall of the discharge tube and towards the gap in the magnetic coil, during the first half cycle of a Θ-pinch discharge. The experimental setup consisted of a quartz tube (40–60 mm dia) containing helium at a pressure 6.7—13.3 n/m^2. The coil current was produced by a 30 μF capacitor bank discharged at 50 kv. The gas was preliminarily excited with a high-frequency generator at 40 Mc and 200 w. The results established experimentally that the displacement of the plasma pinch in the first half cycle is due to nonaxiality of the discharge tube and the magnetic coil, although a final clarification of the nature of the displacement of the pinch is still necessary. In some experiments a conducting screen was placed on the outside of the discharge tube, and it was shown that the screen reduces the influx of impurities into the discharge. An initial magnetic field bucking the external field causes the pinch stability to deteriorate at approximately the first maximum of the compressing magnetic field. (JPRS)

6768 MEASUREMENTS OF THE TWIST ANGLE AND THE ANGLE OF POWER LINE TURN IN A SYSTEM WITH HELICAL MAGNETIC FIELD. B. P. Il'enko, V. G. Zykov, E. M. Lats'ko, and V. T. Tolok. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 211-16(1963). (In Russian)

The confinement of plasma in traps of the stellarator type is discussed. An experimental investigation of the twist angle and turning angle in systems with helical magnetic fields, using a vacuum chamber 9 cm in diameter and 140 cm long (straight copper tube) is reported. The longitudinal magnetic field was produced by 12 single-layer coils and had a maximum in the axial direction of 3.4×10^4 A/m. The charged particles were confined in the stellarator by external magnetic field in which each force line was gradually wrapped around the axial line of the chamber. The twist angle of the force lines was measured with the aid of a rotating electron gun. The measurement results were compared with the theoretical formula. The force-line rotation angle was measured on the curved section of the stellarator model in a longitudinal magnetic field 7.2×10^4 A/m and at a current of 1100 A in the coil. The measurements showed that the angular rotation of the beams on the external side of the curvilinear section is larger than on the external side. This difference does not affect the motion of the particles in the closed system, since the average turning angle remains the same and depends only on the radius. The measurement results showed satisfactory agreement with the calculated data. (JPRS)

6769 MAGNETIC FIELD OF HELICAL CURRENTS FLOWING ON THE TORUS SURFACE. V. F. Aleksin. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 216-24(1963). (In Russian)

The results of the calculation of the magnetic fields of helical currents flowing in an infinitesimally thin conductor comprising a closed helical line on the surface of a circular torus are presented. These calculations become much simpler if use is made of the fact that in real installations the pitch of the helix of the winding and the radius $\underline{R}$ of the center line of the torus are large compared with the radius of the transverse cross section of the torus $\underline{a}$. The magnetic field is best obtained in this case in the form of a series in powers of the small parameter a/R. The calculations are simplified for the case of a small degree of toroidality and a large winding pitch. General expressions are obtained in the case of an n-cusp winding with alternating direction of the current, with consideration of the special cases of double-cusp entry and triple-cusp windings. In the latter case the force lines comprise two magnetic axes, and the corresponding equations can be investigated by the phase-plane method. The geometry of the magnetic force lines and the magnetic surfaces is discussed. (JPRS)

6770 ON THE BEHAVIOR OF FORCE LINES IN A HELICAL MAGNETIC FIELD. V. F. Aleksin. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 224-7(1963). (In Russian)

An exact solution is obtained for the differential equation for the force lines in a helical magnetic field in the vicinity of the separatrix, where perturbation theory or the method of averaging are not effective. The case of a three-cusp field with cylindrical symmetry is considered. The equations show that the radial coordinate of the force lines varies with the longitudinal coordinate periodically, with a period that is expressed in terms of elliptic functions. The angular variation is also expressed in terms of the same elliptic functions. The results of the calculation confirm an earlier approximate formula, except near the separatrix,

where the error of the first approximation becomes appreciable. (JPRS)

6771 INVESTIGATIONS OF PLASMA BUNCHES BY MEANS OF THERMOCOUPLES. I. I. Demidenko, N. I. Mitina, and V. G. Padalka. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 228-31(1963). (In Russian)

The preparation of a bismuth-silver thermocouple for plasma research is described. The thermocouples were produced free-standing by evaporation in vacuum on a heated glass substrate and were used to investigate plasmoids from a Bostick source. The method of separating the thermocouple from the substrate is described. The relative distribution of the energy of the plasmoids as a function of the distance from the source was measured with the thermocouples. The motion of the plasmoid past the thermocouple charged the latter to a certain negative potential which could be monitored on an oscilloscope. The passage of plasmoids in a longitudinal magnetic field was also investigated with the thermocouples. The velocity of the plasmoid could be determined from the delay in the thermocouple signal, and was found to be $(1-1.5) \times 10^5$ m/sec, which is considered to be an overestimate. It is concluded that the described thermocouples are sufficiently sensitive and can be used to investigate the diffusion of plasma transverse to a magnetic field. (JPRS)

6772 INDUCTION CONICAL SOURCE OF PLASMA BUNCHES. Yu. S. Azovskii, I. T. Guzhovskii, Yu. P. Mazalov, V. V. Mank, B. G. Safronov, and V. A. Churaev. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 237-50(1963). (In Russian)

An inductive plasmoid source with a conical single-turn coil was investigated, and the plasmoids produced by it were studied by recording the visible radiation of the plasmoids with a photomultiplier and by recording the plasmoid currents with magnetic probes. The plasmoid velocity was determined from the Doppler effect produced when microwave radiation is reflected from the front of the plasmoid. The charged-particle density in the plasmoid was determined by the microwave-signal cutoff method, and the mass composition of the plasmoid was determined with a Thomson mass analyzer. The conclusions drawn from the results are as follows: The sources produce hydrogen plasmoids with density exceeding 2×10^{14} cm^{-3} at an average velocity 3×10^6 m/sec (450 ev) and a total number of particles 10^{19} (approximately 0.5 cm^3). The total plasmoid energy is of the order of 1,000 J (25% of the energy fed to the coil and 8% of the capacitor-bank energy). The currents circulating in the plasmoids are of the order of 10^4 amp and attenuate far away from the source. The plasma impurities amount to about 10% (only 1% in the front part of the plasmoid) and the plasmoid length is relatively large (6-8 meters). The source efficiency can be increased by preionization of the neutral gas. (JPRS)

6773 CONICAL SOURCE OF PLASMA BUNCHES. Yu. S. Azovskii, I. T. Guzhovskii, B. G. Safronov, and V. A. Churaev. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 250-5(1963). (In Russian)

Plasmoids produced by a conical source were investigated in an experimental setup consisting of a plasma source and a vacuum chamber. The vacuum chamber was a glass tube with inside diameter 60 mm. The initial pressure in the vacuum system did not exceed 2×10^{-5} mm Hg. The plasmoid parameters were investigated with the following equipment: photomultiplier to register the glow of the ionized gas, magnetic probe to register the variation of the external magnetic field due to the plasmoid motion (or the magnetic field of the plasmoid currents in the absence of an external field), and the velocity of the plasmoid layer with density 1×10^{12} cm^{-3} was determined by the microwave signal cutoff method with a signal of frequency 9.5×10^9 c. Oscillograms of all these data were used to determine the delay curves, the dependence of the plasmoid velocity on the initial capacitor bank voltage, and the dependence of the plasmoid velocity on the energy fed to the plasma source. The investigation confirmed the previously obtained results. To ascertain the effect of different parameters of the discharge circuit on the source operation, several capacitor banks were used with different ratios of the total circuit inductance to the source inductance. (JPRS)

6774 COAXIAL PLASMA ACCELERATOR. A. G. Belikov, V. P. Goncharenko, V. M. Mishchenko, B. G. Safronov, and A. S. Slavnyi. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 255-61(1963). (In Russian)

A coaxial electrodynamic plasma accelerator is investigated in order to determine some of its parameters, namely the plasmoid velocity, the plasmoid density, the contamination of the plasma with heavy ions, and the energy distribution of the ions. The electrodynamic plasma accelerator consists of two coaxial cylinders (72 and 32 mm inside diameter, length of accelerating electrodes 175 mm). The pressure used was $(1-3) \times 10^{-3}$ n/m^2, and the working volume was filled with gas using a pulsed valve. The acceleration of the plasma by the coaxial accelerator was investigated as a function of the delay between the start of the entry of the gas into the working volume (more accurately, the start of operation of the hammer of the valve) and the discharge of the source. The discharge was investigated with an internal magnetic probe. The plasmoid velocity was measured with optical (photomultiplier) and external magnetic probes. The mass composition and the energy of the ions of the plasmoids were determined by the Thomson parabola method. The results showed that two plasmoids, moving with different velocities, are produced during the acceleration of a plasma with a coaxial electrodynamic source. The formation of the plasmoids is not connected with the periodicity of the discharge in the source. Further research is necessary to ascertain the nature of the first plasmoid. The charged-particle density exceeds 10^{13} cm^{-3}, the hydrogen ion energy in the fast plasmoid reaches 4-5 kev, and the plasmoid impurities are high, 50-60% in the slow plasmoid and less in the fast one. Exact determination of the impurity contents in the fast plasmoid is difficult. (JPRS)

6775 PLASMA CAPTURE IN A MAGNETIC TRAP. V. G. Zykov, I. A. Stepanenko, V. T. Tolok, and K. D. Sinel'nikov. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 262-73(1963). (In Russian)

Experiments are reported on the confinement of a plasma in a trap with bucking fields, with simultaneous injection of plasma in the opposite direction. The apparatus consists of a cylindrical vacuum chamber 20 cm in diameter made of stainless steel and placed inside the field-producing coils. Each coil is connected to buck the neighboring one, so that three traps with sharp-angle magnetic field geometry are produced, with a 15.6 cm distance between magnetic gaps. Conical plasma guns were used. The plasma was injected into the apparatus pumped out to 6.6×10^{-4} n/m^2. The central trap was the principal one and the outer ones served for injection of the plasma into the central trap. Double electrostatic probes were used to measure the ion density, the electron temperature, and the time dependence of the density. The plasma propagation in the trap was investigated by using targets of photographic paper, the surface of which burned out after several impacts by the plasma. The apparatus and the probes are described in detail. The interaction of the opposing plasma streams is confirmed by several of the results of the investigations. Estimates also show that Coulomb interaction exists between the plasmoid particles. It is pointed out that both the apparatus and the method are preliminary and this affects the accuracy of the final results. (JPRS)

6776 PLASMA INJECTION THROUGH A RING SLIT IN A TRAP WITH OPPOSING MAGNETIC FIELDS. V. G. Zykov, I. A. Stepanenko, V. T. Tolok, and K. D. Sinel'nikov.

Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 273-83(1963). (In Russian)

With an aim at reducing the particles lost when a plasma is injected into the trap through one of the axial magnetic mirrors, the injection of plasma through the annular gap in the magnetic field from sources distributed around the gap periphery was investigated. Experiments in which injection was investigated both in a stationary gap in the magnetic field, as well as in the gap existing during a certain time (magnetic valve), are reported. To simplify the initial experiments, the injection gap was produced by a constant field, with the coils connected to buck each other. A 20-cm diameter and 180-cm long cylindrical stainless steel vacuum chamber was used. Eight conical plasma guns were distributed uniformly around the periphery of the chamber in the magnetic gap plane. The synchronization circuit permitted simultaneous switching of all eight guns or a fraction of them. The plasmoids injected by each gun had a density 2×10^{14} cm^{-3} and a velocity of 3×10^4 m/sec. The working vacuum was 6.6×10^{-4} n/m^2. The maximum magnetic field intensity, equal to 2×10^5 A/m, was located 40 cm away from the magnetic gap. The experiments showed that a plasma injected into a gap between opposing magnetic fields moves subsequently along the system axis. A strong interaction was observed between the opposing plasma streams, even in the absence of external magnetic fields. (JPRS)

6777 DIFFUSION OF HETEROGENEOUS RAREFIED PLASMA INDUCED BY EXCITATION OF ION-ACOUSTIC OSCILLATIONS. V. D. Shapiro. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 318-32(1963). (In Russian)

An approximate theory, which takes into account the influence of oscillations on transport phenomena in the plasma, is used to estimate the diffusion coefficient in an inhomogeneous plasma, due to the buildup of ion-acoustic oscillations. The diffusion is analyzed both at the initial stage of development of the oscillations, and also for the stationary oscillations. The analysis is limited to high-temperature and rarefied plasma without pair collisions. An unbounded inhomogeneous plasma in a magnetic field parallel to the z axis is considered. The kinetic equation is solved by expansion in the reciprocal of the magnetic field and the equation for the variation of the distribution function of the background due to the excitation of the oscillations is obtained by averaging. The stationary amplitudes of the ion-acoustic oscillations are determined and are found to be small, thus confirming the validity of the quasilinear approximation. The diffusion coefficients of the electrons and ions, due to the ion-acoustic oscillations, are found to be of the same order of magnitude at the saturation stage. It is concluded that the ion-acoustic oscillations lead to an additional diffusion of the electrons and ions of the plasma transversely through the magnetic field, but this diffusion is small. In view of the smallness of this contribution to the total diffusion, other possible mechanisms of anomalous diffusion become significant and worthy of study. (JPRS)

6778 DIFFUSION OF COMPLETELY IONIZED PLASMA ACROSS A MAGNETIC FIELD. V. F. Aleksin and N. A. Khizhnyak. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 332-6(1963). (In Russian)

It is shown that in a fully ionized gas the coefficient of thermal conductivity is $(M/m)^{\frac{1}{2}}$ times larger than the diffusion coefficient (M – ion mass, m – electron mass), so that the gradient of temperature becomes equalized much more rapidly than the density gradient and the former need be taken into account only on the plasma boundary. The diffusion of a plasma pinch detached from the walls in a longitudinal magnetic field, or the diffusion of a plasmoid in a reference frame connected with the plasmoid, is considered neglecting longitudinal spreading. It is assumed that the plasma is stable against various types of disturbances. It is shown that the self-similar solution describes well the qualitative pattern of diffusion of the plasma pinch transversely to the magnetic field for arbitrary initial smooth particle-density distribution. Self-similar solutions can also be obtained for the temperature distribution. Magnetohydrodynamic instabilities can cause plasma to leave the pinch at a rate close to the thermal velocity of the ions. On the other hand, instability can produce turbulences in the plasma and also consequently increase the diffusion. (JPRS)

6779 PLASMA DECAY IN A MAGNETIC FIELD. G. A. Silinok-Bel'skii and Yu. Ya Volkolupov. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 337-43(1963). (In Russian)

The effect of the magnetic field on the diffusion of plasma in a direction transverse to the field was investigated in two series of experiments, one in fields up to 0.15 Tesla and the other up to 0.3 Tesla. The theory underlying the experiments and the experimental apparatus are described. The plasma was excited in a quartz tube 20 mm in diameter situated in a constant magnetic field; the homogeneous part of the magnetic field was 40 cm long in the first series of experiments and 150 in the second. The inhomogeneity did not exceed 1%. The decay of the plasma was determined from the shift of the natural frequency of the 10-cm resonator operating in the $E_{\theta 18}$ mode. The quantity measured directly in the experiment was the change in the natural frequency of the resonator as a function of the time. The experimental plots of the diffusion against the magnetic induction, obtained for small degrees of plasma anisotropy indicate that diffusion transverse to the magnetic field is due to pair collisions. These results agree qualitatively with results obtained in the study of transverse diffusion in argon. In the case of strong anisotropy the predominant mechanism is recombination. The recombination coefficient for hydrogen was found to be 2×10^{-6} cm^3/sec. The relatively large recombination coefficient and the relatively broad region of transition from diffusion to recombination loss may imply the presence of additional losses in the case of strong anisotropy. (JPRS)

6780 MICROWAVE METHODS IN PLASMA BUNCH DIAGNOSTICS. Yu. S. Azovskii, I. T. Guzhovskii, L. A. Dushin, V. I. Privezentsev, and V. A. Churaev. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 348-53(1963). (In Russian)

Several microwave methods were used to determine the density and translational velocity of charged particles in a plasmoid. The plasmoids were obtained with a conical source from a 6.1 μF capacitor bank. The plasmoid propagated in a glass tube 60 mm in diameter and 1.2 meters long. The pressure in the vacuum system did not exceed 2.7×10^{-3} n/m^2. The electron density was determined from the "cutoff" of the microwave signal, corresponding to the critical density for the given frequency. The plasmoid velocity was determined by the Doppler effect, except that the velocity of the layer with low electron density ($10^{10} - 10^{11}$ cm^{-3}) was determined by measuring the detuning of a cavity resonator. The tests have shown that different layers of the plasmoid move with different velocities and this causes the leading front of the plasmoid to become less steep as it moves. (JPRS)

6781 STUDIES OF THE POSITIVE ION BEAM EFFECTS ON THE BLACKENING OF PHOTOPLATES. L. I. Krupnik and N. G. Shulika. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 353-7(1963). (In Russian)

The blackening of photographic plates as a function of the number of H^+, $^2H^+$, $^3H^+$, $^4He^+$, $^{12}C^+$, $^{14}N^+$, and $^{16}O^+$ ions with energies from 10 to 20 kev was investigated in view of the possible use of photographic emulsions to determine qualitatively the composition of plasmoids. The ions were produced with a high-frequency ion source focused, mass analyzed, collimated, and cleared of neutral particles after which they struck the photographic plate.

The measurement procedure and the apparatus are described. The plates were developed and the density measured with a microphotometer. All the ions produced saturation, indicating that all grains of the emulsion reacted with the ions and a further increase of the charge does not increase the intensity. The photographic blackening also decreases uniformly with the increasing mass. The errors of the procedure are discussed briefly. (JPRS)

6782 MICROWAVE METHODS FOR INVESTIGATIONS OF PLASMA IN AN EXTERNAL MAGNETIC FIELD. L. A. Dushin, V. I. Privezentsev, and A. I. Skibenko. Fiz. Plazmy i Probl. Upravlyaemogo Termoyader. Sinteza, Akad. Nauk Ukr. SSR, Fiz.-Tekhn. Inst., Dokl. Tret'ei Konf., Khar'kov, 1962, 357-64(1963). (In Russian)

The theory of propagation of radio waves in magnetoactive plasma is used as a basis for an experimental investigation of transverse propagation of a plasma in a pulsed Philips source with a discharge tube made of molybdenum glass 130 cm long and 10 cm in diameter. An external homogeneous magnetic field of sinusoidal form was used with a period much longer than the lifetime of the plasma. The field amplitude could be varied from 0 to 640 kA/m. The measurements were made during the time of plasma decay. Experiments were made also for longitudinal propagation of the plasma. They showed that the use of longitudinal propagation for diagnostics can be quite effective in the case of a high-density plasma, when measurements at relatively low frequencies (compared with the plasma frequency) are possible. High accuracy can be attained by satisfying the conditions of geometrical optics, choosing the ratio of the time of pulse passage to the period of the signal frequency, and allowing for the inhomogeneity of the plasma. The experiments indicate that the methods described can be useful for a permanent or quasipermanent magnetic field. The use of transverse propagation is particularly effective when the magnetic field is on the low side of resonance and close to it. Longitudinal propagation is effective when the electron density of the plasma varies little along the length of the column. Longitudinal measurements are also convenient because high plasma concentrations can be measured with the aid of decimeter and centimeter wavelengths. (JPRS)

6783 PERFORMANCE OF THE He–Ne GAS LASER AS AN INTERFEROMETER FOR MEASURING PLASMA DENSITY. D. E. T. F. Ashby, D. F Jephcott, A. Malein, and F. A. Raynor (United Kingdom Atomic Energy Authority, Abingdon, Berks, Eng.). J. Appl. Phys., 36: 29-34 (Jan. 1965). (CLM-P-38)

The characteristics of the He–Ne gas laser used in a new simple interferometric technique were studied experimentally and theoretically. The interferometer has two novel features: first, the intensity of the laser itself is used to detect the fringes and second, because the intensities of the 0.63-μ (red) and 3.39-μ (infrared) laser beams are coupled, interference in the infrared can be detected by a simple photomultiplier monitoring the red beam. The system does not respond instantaneously to changes in the optical path length; experimental measurements show that when the red beam is used to follow interference in the infrared, the maximum detectable response is limited to about 3×10^6 fringes per second. Discussion of the frequency response and the cross-coupling between the two wavelengths leads to the conclusion that the frequency response is limited by the red channel only. Experimental details of the interferometer are described, including the application of a multipass system which, with some loss in spatial resolution, increases the sensitivity of the interferometer by at least a factor of 20. (auth)

6784 EXPERIMENTAL SEPARATION OF COLLECTIVE AND INDIVIDUAL PHENOMENA IN PLASMAS ANOMALOUS RESISTANCE. K. I. Thomassen (Stanford Univ., Calif.). J. Appl. Phys., 36: 62-5(Jan. 1965).

An experimental method for separating collective effects from collision dominated phenomena in plasmas consists of probing the plasma at a frequency between the collision and plasma frequencies that govern the rates of the individual and collective processes. This method is applied to the measurement of anomalous resistance by utilizing a reentrant cavity to expose a quiescent plasma to the strong electric fields at this intermediate frequency, thus provoking anomalous resistance. The resistive loading of the cavity is then observed as a function of power level or field strength, giving evidence of an anomalous resistance above power levels which initiate the two-stream instability. (auth)

6785 EFFECTS OF A MAGNETIC FIELD ON ELECTRON PROBE CURRENTS. Minoru Sugawara (Central Research Inst. of Electric Power Industry, Tokyo) and Yoshisuke Hatta. J. Appl. Phys., 36: 314-15(Jan. 1965).

Measurements on the electron probe current across a magnetic field are reported, and the electron probe current is interpreted in terms of diffusion of electrons. (C.E.S.)

6786 SOME CHARACTERISTICS OF PULSED Na- AND Tl-IODIDE MONATOMIC GAS ARCS. P. D. Johnson and T. H. Rautenberg, Jr. (General Electric Research Lab., Schenectady, N. Y.). J. Opt. Soc. Am., 54: 1425-8 (Dec. 1964).

The spectral distribution, intensity, and excitation temperature were measured for pulsed discharges in sodium and thallium iodide vapors with mercury or argon. Peak plasma temperatures were in the neighborhood of 10,000°K. Both peak intensity and peak plasma temperature increased less than linearly as functions of energy input at energies over 5 J/cm^3 of arc tube volume. In comparison with continuous operation, both the mercury spectrum and a continuum were enhanced relative to the iodide spectrum in pulsed NaI–Hg and TlI–Hg arcs, and the Na or Tl and Hg lines became strongly broadened. The radiant output of Na or Tl in iodide–argon pulsed arcs was limited by lack of significant line broadening. (auth)

6787 NEGATIVE CHARACTERISTIC OF A CYLINDRICAL PROBE IN A MAGNETIC FIELD. Toshihiko Dote and Hiroshi Amemiya (Inst. of Physical and Chemical Research, Tokyo). J. Phys. Soc. Japan, 19: 1915-24(Oct. 1964).

A negative current-voltage characteristic was obtained for a cylindrical probe with its axis parallel to the magnetic field in Ar, Kr, Hg, and Ne plasmas above a critical magnetic field value that varies with pressure. The cylindrical probe was analyzed using the orbital motion theory inside the sheath. It was shown that the negative characteristic can be attributed entirely to electron motion (impaired in the transverse direction). (D.C.W.)

6788 A NEW APPROACH TO THE THEORY OF RELAXATION IN PLASMAS. Naobumi Honda (Tokyo Univ.). J. Phys. Soc. Japan, 19: 1935-54(Oct. 1964).

A quantum-mechanical treatment of relaxation phenomena in high-temperature plasmas is developed. For a test particle moving with a momentum in a plasma, the transition probability for the scattering to another momentum state due to interactions with plasma particles is calculated exactly. Both the binary and the collective interactions are included. With use of this transition probability, relaxation rates with exact numerical factors in the arguments of Coulomb logarithms are obtained. It is also shown that Kihara's connection formula can be derived in the present scheme. (auth)

6789 PULLING EFFECT OF A NATURAL LOW-FREQUENCY OSCILLATION IN A GASEOUS PLASMA BY AN APPLIED SIGNAL. Hiroshi Suzuki (Matsushita Electronics Corp., Osaka), Noriyoshi Sato, and Yoshisuke Hatta. J. Phys. Soc. Japan, 19: 1983(Oct. 1964).

Natural low-frequency oscillations of several tens of kilocycles were self-excited above a certain value of the discharge current in a mercury vapor tube. When an external signal within a certain frequency range was applied to a grid, the frequency of the natural oscillation was pulled to that of the applied signal. (D.C.W.)

6790 ELECTRON TEMPERATURE IN A LASER-HEATED PLASMA. E. Archbold and T. P. Hughes (National Physical Lab., Teddington, Middx., Eng.). Nature, 204: 670(Nov. 14, 1964).

Experiments were carried out using a large Q-switched neodymium glass laser, and an estimate of the electron temperature attained in a carbon plasma is reported. Using a graphite target, a single laser pulse was sufficient to produce a spectrogram on which lines of the C I, II, III, IV, and V spectra were identified. A Maxwellian distribution of electron velocities was assumed. An expression for the specific intensity, I, divided by the product of the number densities of electrons, n_e, and of quadruply ionized carbon atoms in the ground state, n_1, was evaluated for the observed C V transition $2s^3S_1$-$2p^3P_2$ at 2270.91 Å and was plotted as a function of the electron temperature, T_e. The lower limit of the peak electron temperature was determined as 1.1×10^5 °K. (P.C.H.)

6791 FORWARD SCATTERING OF LIGHT FROM A LABORATORY PLASMA. U. Ascoli-Bartoli, J. Katzenstein, and L. Lovisetto (EURATOM-CNEN, Frascati, Italy). Nature, 204: 672-3(Nov. 14, 1964).

Results obtained on a laboratory plasma for scattering at angles sufficiently small for collective effects to be dominant as contrasted with other work at large angles are reported. The experimental arrangement is illustrated. Light from a Q-switched ruby laser is sent down the axis of a Θ-pinch discharge and caught in a light trap beyond. The laser emits a single pulse of 20 nsec duration and a power of either 1.5 or 15 Mw depending on the temperature of the ruby. Light scattered at angles of 3° is collected from the plasma by the combination of a lens, axicon, and focal plane stop. The ion spectrum is taken with an etalon adjusted for a free spectral range of 0.8 Å. The maximum of the ion peak is shifted toward shorter wavelengths. Except for asymmetries toward shorter wavelengths the data are consistent with the theory and the expected behavior of a small Θ-pinch. (P.C.H.)

6792 CONDUCTIVITY OF A WARM PLASMA TO AN OSCILLATING ELECTRIC FORCE IN THE PRESENCE OF A STRONG MAGNETIC FIELD. T. Koga (Polytechnic Inst. of Brooklyn). Nuovo Cimento (10), 34: 987-1009(Nov. 16, 1964).

By assigning an equation of the Boltzmann type to each species of particles and treating these equations under the assumption that the field is spatially uniform, the electric conductivity of a warm plasma, composed of electrons, ions of one species, and neutral molecules of one species, in the presence of a stationary magnetic field is investigated. This treatment takes into account the collisions among particles. The electric force due to the collective displacements of charged particles is considered as distinguishable from the other part of the total electric force. The three resonant frequencies defined are the natural frequencies of the system. The application of the results to radio waves and magneto-acoustic waves is suggested under various conditions. Due to the assumption of spatially uniform field in treating the conductivity, the application is valid only when the phase speed of a wave is higher than the average speed of thermal motions of particles. (auth)

6793 STAGNATION-POINT HEATING IN IONIZED MONATOMIC GASES. James P. Reilly (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 7: 1905-12 (Dec. 1964).

The heat transfer to the stagnation point of a cylinder in partially ionized monatomic gases was measured, and the effect of free electrons on the total gas thermal conductivity was assessed. Shock-heated argon and xenon were used as the test media, thus bypassing the dissociation phase present in diatomic gas heat transfer, and passing directly from the ideal gas to the ionized gas. Comparison of the experimental data is made with two real-gas estimates, the first including the effects of ionization only on the thermodynamic properties involved, and a second including the effects of ionization on both the thermodynamic and transport properties. The experimental results are in substantial agreement with the latter prediction where equilibrium is attained and confirm the prediction of an increased gas thermal conductivity due to the presence of free electrons. An estimate of the contribution of radiative heating is made both numerically and experimentally, and is found to be less than 10% of the aerodynamic heating for the test conditions. The test gas is shown to be in thermochemical equilibrium under those conditions in which ionization is significant. (auth)

6794 SOLUTION OF THE KINETIC EQUATION FOR AN UNSTABLE PLASMA IN AN ELECTRIC FIELD. Edward C. Field (Univ. of California, Los Angeles) and Burton D. Fried. Phys. Fluids, 7: 1937-51(Dec. 1964).

The response of a homogeneous plasma to the sudden application of a strong, uniform electric field, E_0, is studied by solving, self-consistently, the coupled equations for the one- and two-particle distribution functions. The field is assumed to be large compared to that which produces a "runaway" current, so that particle–particle collisions have a negligible effect on the current flow, and particle–wave interactions dominate. The principal approximations are the neglect of intrinsic three-particle correlations (linearization in fluctuations) and the use of an adiabatic ansatz for the time dependence of the fluctuations. For the case of unequal temperatures, $T_e \gg T_i$, two different methods of solution are employed: a moment approximation, in which the distribution functions are assumed to be Maxwellian with the mean velocity and width determined self-consistently; and a more exact treatment in which the distribution function for velocities parallel to the applied field is determined by direct numerical solution of the kinetic equation using on-line computational techniques. In both cases, it is found that the unstable ion acoustic waves grow from the thermal fluctuation level to a magnitude sufficient to cause a sharp and sudden decrease in the current. Examination of the kinetic equation shows this drop to be ascribable to the dynamic friction associated with the unstable waves. Although waves propagating parallel to the applied field are most important at early times, those propagating at finite angles soon become dominant; this casts some doubt on one-dimensional approximations to this problem. The limitation of the exponential growth of unstable waves resulting from the non-linear (or quasilinear) effects is clearly evident, notwithstanding the presence of the external driving force, E_0. (auth)

6795 KINETIC THEORY OF RADIATION IN A PLASMA. R. E. Aamodt, O. C. Eldridge, and N. Rostoker (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 7: 1952-9(Dec. 1964).

A kinetic theory of a fully ionized plasma with the transverse electromagnetic field expanded in vacuum normal modes is developed. The Bogoliubov-Born-Green-Kirkwood-Yvon hierarchy of equations is terminated using only an expansion in the plasma discreteness parameters e, m, and 1/n. The renormalization of the vacuum field on a fast time scale is discussed for an infinite homogeneous plasma, and a superposition principle for dressed test particles is derived. (auth)

6796 LANDAU DAMPING AND RELATED PHENOMENA. David B. Chang (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 7: 1980-6 (Dec. 1964).

The physical interpretation of the Vlasov equation singularity-related phenomena (Landau damping, quasi-linear phase-space diffusion, and wave–wave scattering) is sought by deriving these phenomena avoiding singularities. The net impulse experienced by a particle in the presence of a damped wave is calculated; and a Fokker–Planck-like equation is constructed to describe the evolution of an ensemble of particles interacting with such waves. The three phenomena are seen to arise directly from the fact that a particle experiences a net impulse in the presence of waves which are growing or damping. (auth)

6797 FINITE AMPLITUDE EFFECTS ON HYDROMAGNETIC WAVES. L. C. Woods (Balliol Coll., Oxford). Phys. Fluids, 7: 1987-95(Dec. 1964). (CLM-P-41)

Hydromagnetic waves traveling along an axial magnetic field in a cylindrical plasma bounded by a conductor have a frequency ω determined by the exciter. The nonlinear terms appearing in the equation of motion and in Ohm's law, usually neglected in wave theory, will induce a small amplitude

wave of frequency 2ω accompanying the basic wave. In addition, the boundary conditions at the exciter will produce further double-frequency waves, but moving at speeds different from the basic wave. The amplitudes of these double-frequency waves are calculated for all the components of the magnetic field and for the plasma density. The existence of certain critical frequencies, at which resonance between the basic and double frequency waves occurs, is established. In the limit as $\Omega \equiv \omega/\omega_{ci}$ tends to zero, the amplitudes of the magnetic double-frequency waves are shown to depend on Ω/ϵ, where ϵ^{-1} is the damping length of the wave, while the corresponding density wave amplitude is found to be independent of both ϵ and Ω. (auth)

6798 THERMALLY INHOMOGENEOUS PLASMA COLUMN. G. Ecker and O. Zoeller (Universität, Bochum, Ger.). Phys. Fluids, 7: 1996-2000(Dec. 1964).

The cylindrical collision-dominated plasma column is investigated, taking into account the temperature inhomogeneities. The balances for the first three momenta of the three particle components are reduced to a system of two coupled differential equations including all temperature effects. These equations reveal a similarity law. The radial density and temperature distributions, together with the characteristic of the plasma column, are presented and compared with Schottky's relations. (auth)

6799 MAGNETOHYDRODYNAMIC STABILITY OF TOROIDAL PLASMAS. A. A. Ware (United Kingdom Atomic Energy Authority, Abingdon, Berks, Eng.). Phys. Fluids, 7: 2006-11(Dec. 1964). (CLM-P-44)

The sufficient stability condition which follows directly from the energy principle is divided into the parts which depend, respectively, on $j_{||}$ and $j_{\perp}$, which are the components of the equilibrium current parallel and perpendicular to the magnetic field. The sufficient condition for $j_{\perp}$ not to cause instability is found to depend on the average normal curvature of the magnetic surfaces in the direction of B. The corresponding condition for $j_{||}$ depends on the average geodesic torsion of the magnetic surfaces in the direction of B. For currents below approximately the Kruskal limit in a circular torus, the average normal curvature becomes negative; and the $j_{\perp}$-modes are stable for negative pressure gradients. This confirms Mercier's earlier results for localized perturbations. On the other hand, to zero and first order in the aspect ratio of the torus (r/R_0), the average geodesic torsion is the same as for a straight cylinder so that there is no toroidal stabilizing effect for $j_{||}$-driven modes. Completely stable toroidal equilibria are possible which do not rely on magnetic shear. The relation of these stability conditions with the $\int (dl/B)$ criterion is discussed. (auth)

6800 SHAPE OF SHOCK FRONTS IN SHOCK TUBES. H. W. Liepmann and R. M. Bowman (California Inst. of Tech., Pasadena). Phys. Fluids, 7: 2013-15(Dec. 1964).

The shape of shock fronts was measured in a 17-in. shock tube at various pressures. The effects of upstream disturbances were studied. The results were compared with calculations by a boundary layer theory. (auth)

6801 A NEW NEGATIVE V'' STELLARATOR CORRUGATION FIELD. John L. Johnson (Princeton Univ., N. J.). Phys. Fluids, 7: 2015-16(Dec. 1964). (MATT-281)

A field configuration is proposed in which small distortions of the magnetic surfaces achieve $V''(0) < 0$. In $V''(\psi)$, V is the volume of a magnetic surface and ψ is the magnetic flux contained. (D.C.W.)

6802 OBSERVATION OF HELICAL DISCHARGE IN THE ABSENCE OF EXTERNAL MAGNETIC FIELD. S. F. Paik and J. K. Silk (Raytheon Research Div., Waltham, Mass.). Phys. Fluids, 7: 2016-17(Dec. 1964).

A helical discharge was observed in an annular tube filled with mercury, when the cathode temperature was gradually lowered from the temperature required to maintain a normal discharge. The pitch of the helix varied with the anode voltage and heater current. The low-frequency noise spectrum of the helical discharge was essentially the same as that of a cylindrical discharge. (D.C.W.)

6803 FORMATION OF THE CATHODE-FALL REGION IN A PULSED GLOW DISCHARGE. M. Nahemow (Polytechnic Inst. of Brooklyn), N. Wainfan, and A. L. Ward. Phys. Rev., 137: A56-60(Jan. 4, 1965).

Results are presented of an experimental and theoretical study of the formation of the cathode-fall region of a pulsed glow discharge in hydrogen at large overvoltages. The calculations are based upon a Townsend avalanche model that takes explicit account of space charge. Both the experimental data and theoretical results give a minimum delay of about 35 nsec for the start of the formation of the cathode-fall region of the discharge. Profiles of the electric field as a function of time at the face of the cathode are given, and calculated profiles of the number density of free electrons are compared with experimentally measured intensity profiles. In both cases there is good agreement between theory and experiment. Since the model used accounts for the observed features of the high-current pulsed discharge, there is no apparent need to invoke any other mechanism to account for the propagating luminous fronts and the short formative times of the cathode-fall region. (auth)

6804 LOCATING ELECTRON SWARMS IN HYDROGEN BY FAR ULTRA-VIOLET SIGNALS. J. M. Breare and A. von Engel (Oxford Univ.). Proc. Roy. Soc. (London), Ser. A, 282: 390-402(Nov. 24, 1964).

An electron swarm is released from a pulsed gas discharge and passes through a hydrogen-filled chamber in which a uniform electric field is maintained whereby some electrons excite and ionize gas molecules by collisions. From observations of the uv signals released by the truncated electron swarm, the drift velocity of electrons, the diffusion coefficient, and the degree of radiation quenching can be derived. The drift velocity is found from time-resolved oscillograms of the intensity of the near and far uv light emitted from two different points in the chamber. Measurements are presented for gas pressures between 2 and 90 mm Hg in reduced fields X/p between 14 and 43 v/cm per unit gas density with a pulse length of the order 10^{-7} sec. The electron drift velocities agree well with those previously observed below X/p = 20, but for larger values of X/p some difference is noted. From the analysis of the light pulses, an effective value of the electron diffusion coefficient is estimated and found to be larger than the value expected from classical theory. Histograms of the light pulses indicate spatial anisotropy of the electron density at low pressure. At higher gas pressures the near and far uv radiation suffers considerable quenching which is most likely associated with dissociation of the molecule. A rough experimental estimate of the quenching cross section of the C-state gives 6.3×10^{-17} cm^2, and for the a-state 2.2×10^{-16} cm^2, which are smaller than earlier values. (auth)

6805 SEEDED-GAS PLASMA FOR LOW DENSITY WIND-TUNNEL USE. Walter Christiansen (California Inst. of Tech., Pasadena). Rev. Sci. Instr., 36: 71-5(Jan. 1965).

A source of low-density plasma is described in which an argon gas stream is seeded with thermally-ionized cesium. The results of preliminary measurements of ion density and electron temperature are included. (D.C.W.)

6806 GAS-TRIGGERED PINCH DISCHARGE SWITCH. R. G. Jahn, W. von Jaskowsky, and A. J. Casini (Princeton Univ., N. J.). Rev. Sci. Instr., 36: 101-2(Jan. 1965).

A switch which discharges in a direct pinch mode is described. The annular discharge gap is evacuated to a pressure considerably below the Paschen limit for argon, the discharge then being initiated by injection of a small amount of argon. (D.C.W.)

6807 DETERMINATION OF ELECTRON DENSITY AND TEMPERATURE IN XENON HIGH-PRESSURE PLASMA. Soemarmo Pranoto and Paul Schulz (Technische Hochschule, Karlsruhe, Ger.). Z. Angew. Phys., 17: 539-42(1964). (In German)

With reference to an earlier method for determination of electron density and temperature in a mercury high-pressure plasma from an electron impact broadening of spectral lines, these values were determined for a xenon

high-pressure plasma. A gas filling of 22 atm xenon under the operating conditions was added to a similar amount of mercury with a partial pressure of 14 torr. The optical and electric data of the discharge were practically unchanged, but for the measurements in question, spectral lines 5770/91 and 5461 Å appeared plainly out of the background. For current strengths of 15 to 35 Å the number of electrons was between 0.8×10^{17} and 1.8×10^{7} cm^{-3} and the temperature was between 7800 and 8700°K. (tr-auth)

6808 THE INFLUENCE OF ELECTRODYNAMIC PROPERTIES OF A PLASMA BUNCH ON ACCELERATION IN A COAXIAL. P. M. Kolesnikov (Khar'kov Aviation Inst.). Zh. Tekhn. Fiz., 34: 1933-8(Nov. 1964). (In Russian)

The effect of voltage-current characteristics on the process of acceleration is considered phenomenologically. The limiting cases of motion are investigated by asymptotic methods. The complete solution of the problem is given by digital computer. (tr-auth)

6809 ELECTRON DISTRIBUTION FUNCTION IN A POSITIVE DISCHARGE COLUMN IN NEON AND HELIUM. N. A. Vorobeva, Yu. M. Kagan, and V. M. Milenin. Zh. Tekhn. Fiz., 34: 2079-81(Nov. 1964). (In Russian)

Electron distribution functions according to velocity were measured in the positive column of a constant-current discharge for pure Ne and He. The discharge pipe and probes are described. Measurements were carried out at 0.08 to 1.3 mm Hg and 50 to 200 ma in He, and at 0.06 to 1.6 mm Hg and 25 to 200 ma in Ne. The distribution functions are presented graphically and compared with Maxwell distributions. (M.J.T.)

6810 ON THE POLARIZATION OF A PLASMOID IN A HOMOGENEOUS AXIALLY SYMMETRIC MAGNETIC FIELD. V. S. Voistenya, A. G. Gorbanyuk, I. N. Onishchenko, B. G. Safronov, and V. V. Shkoda. Zh. Tekhn. Fiz., 34: 2083-5(Nov. 1964). (In Russian)

Results are presented from a study of electric fields in a plasma cluster moving in the homogeneous magnetic field of a direct solenoid. The apparatus is described. Typical curves of the distribution of the potential and the radial electric field are presented; potential distributions for different injection conditions are compared. It is concluded that the radial electric field in a plasma moving in a homogeneous magnetic field is not related to effects arising on the magnetic field gradient. It is more quickly caused by the difference of radii of revolution of ions and electrons in the magnetic field or by the presence of uncompensated volume negative discharge. The electric field also may arise in plasma revolution. (M.J.T.)

6811 ION AND PLASMA TECHNOLOGY. Warren D. Rayle (Lewis Research Center, Cleveland). P.113-18 of "NASA SP-5015."

Developments in the field of ion and plasma technology are discussed. (J.R.D.)

6812 ELECTRON-STREAM INTERACTION WITH PLASMAS. Richard J. Briggs. Research Monograph No. 29. Cambridge, Mass., Massachusetts Inst. of Tech., 1964. 195p. $7.50.

The instabilities that result when an electron beam is injected into a plasma are considered. A number of different models of the system are discussed, and all instabilities are classified according to whether they are convective or nonconvective instabilities. The instabilities in unbounded beam-plasma systems and in systems of finite extent transverse to the electron stream are analyzed. The possibility of a strong interaction with the ions in a hot-electron plasma is considered. Mathematical criteria for identifying absolute instabilities and amplifying waves are presented. These criteria are based only on an analysis of the dispersion equations of the system and are not restricted to beam-plasma systems. A bibliography of 77 references is included. (C.E.S.)

6813 ON THE PROBLEM OF OPTIMUM COMPOSITION OF CONDUCTIVE GASEOUS MIXTURE. E. P. Zimin and V. A. Popov (Inst. of Energetics "Krjijanovsky", Moscow). 16p. (CONF-640701-60)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The composition of a gas mixture (seeding largely nonionizing) which gives the maximum conductivity was analyzed. The conductivity of a potassium-seeded methane-oxygen flame was determined from the attenuation of radio waves in the region of large values of the partial pressure. The effect of a magnetic field on the attenuation of radio waves in a slightly conductive gas was also studied experimentally. (D.C.W.)

6814 FORMATION OF SPACE CHARGE SHEATHS AND FLOW OF AN ELECTRIC CURRENT IN A PLASMA STREAM. INVESTIGATIONS OF IONIZATION CHARACTERISTICS OF PLASMA STREAMS IN AN ELECTRIC FIELD. A. K. Musin (Lenin All-Union Electrical Inst., Moscow). 11p. (CONF-640701-63)

From International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris.

The development of the electric current and space-charge sheaths in the flow of a uniform plasma at constant velocity into a space between two plane electrodes to which a constant external voltage is applied was analyzed. Electron densities and positive ion mobilities were derived from experimental results on the ionization properties of flames, using the theory. The values obtained were in good agreement with those obtained by other methods. (D.C.W.)

6815 EXPERIMENTS WITH A CO-AXIAL HALL CURRENT PLASMA ACCELERATOR. William Grossmann (National Aeronautics and Space Administration, Hampton, Va.), Robert V. Hess, and H. A. Hassan. New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-700, 18p, $1.00. (CONF-640801-18)

From 4th Electric Propulsion Conference, Philadelphia.

A coaxial Hall current plasma accelerator was studied using argon, helium, and nitrogen at low mass-flow rates. The Hall currents and their variations with arc current and applied magnetic field were investigated, together with the thrust and specific impulse. Anomalously high thrusts and specific impulses were found with argon and nitrogen at comparatively low interelectrode potentials. (D.C.W.)

6816 X-BAND MAGNETIC RESONANCE PLASMA ACCELERATOR. David B. Miller (General Electric Co., Philadelphia). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-702, 19p, $1.00. (CONF-640801-21)

From 4th Electric Propulsion Conference, Philadelphia.

An electron-cyclotron resonance accelerator using a circularly-polarized, TE_{11} mode circular wave-guide field was studied. The frequency was 8350, and operation to above 3 kw of incident r-f power was achieved. Argon plasmas were used with flow rates of 0.3 to 1.0 mg/sec. The incident and reflected r-f power, r-f field penetration in the plasma, and power loss to the accelerator walls were investigated, together with the emerging plasma stream. The dependences of the plasma characteristics on the r-f power, gas flow rate, and magnetic field were obtained. (D.C.W.)

6817 AN ENERGY INVENTORY IN A COAXIAL PLASMA ACCELERATOR DRIVEN BY A PULSE LINE. A. V. Larson, T. J. Gooding, B. R. Hayworth, and D. E. T. F. Ashby (General Dynamics/Astronautics, San Diego, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-704, 14p, $1.00. (CONF-640801-25)

From 4th Electric Propulsion Conference, Philadelphia.

A description is given of energy measurements in a coaxial plasma gun. The energy source was a pulse line, which is essentially an extended foil capacitor wound on a large diameter core; when discharged into the gun it delivers 200 kamp at 3 kv with a rise time of 0.1 μsec. The partition of energy between the source, magnetic field, and work done on the plasma is determined from measurements of the magnetic field distribution inside the gun together with the voltage and current at the gun terminals. 88% of the stored energy is delivered to the gun initially, of which roughly half is in magnetic field. Some magnetic

energy is withdrawn before crowbar, but finally 58% of the stored energy does work on the plasma. Calorimetric measurements showed that only 15% of the stored energy appears in the exhaust; this percentage doubles if the barrel is shortened from 13 to 8 cm. The results are discussed on the basis of a shock model in which the plasma radiates its internal energy. (auth)

6818 EXHAUST MEASUREMENTS ON THE PLASMA FROM A PULSED COAXIAL GUN. D. E. T. F. Ashby, T. J. Gooding, B. R. Hayworth, and A. V. Larson (General Dynamics/Astronautics, San Diego, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-705, 14p, $1.00. (CONF-640801-26)

From 4th Electric Propulsion Conference, Philadelphia.

A negatively biased Faraday cup was used to measure the ion current in nitrogen plasma from a pulsed coaxial gun, from which the ion density and velocity were determined. Plasmas with ion densities to 3×10^{13} cm^{-3} and with directed ion velocities of 10^6 to 10^7 cm sec^{-1} were studied. The energy density was calculated from the Faraday cup data and was compared with the value obtained using a small calorimeter. An electrostatic analyzer with a biased grid was used to check the Faraday cup and to determine the charge/mass ratio for the ions. (D.C.W.)

6819 A MODEL FOR A PULSED PLASMA ACCELERATOR. Thomas Donner (Republic Aviation Corp., Farmingdale, N. Y.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-709, 21p, $1.00. (CONF-640801-28)

From 4th Electric Propulsion Conference, Philadelphia.

A model describing the behavior of a pulsed plasma accelerator is derived from experimental data. The plausibility of the model is investigated, and the limiting conditions under which the model is believed to be applicable are discussed. The model deals with accelerators characterized by relatively low rates of change of discharge currents in which the rate of change of magnetic flux is primarily dependent on the current associated with the moving front and the front velocity, while the initial breakdown and the front formation are controlled by the plasma resistivity rather than by inductive effects. The model, in conjunction with experimental data, is used to calculate the energy partition in the accelerator. (auth)

6820 PULSED GAS INDUCED ELECTRICAL BREAKDOWN IN PLASMA ACCELERATORS. Maurice E. Levy and Allan J. Schwalb (Astrosystems International, Inc., Fairfield, N. J.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-707, 10p, $1.00. (CONF-640801-29)

From 4th Electric Propulsion Conference, Philadelphia.

The process of cold gas propellant injection and subsequent electrical discharge initiation within the interelectrode space of a propellant triggered plasma pinch accelerator were studied experimentally and analyzed. A theoretical formulation of the idealized flow field characteristics of the injected propellant was obtained, together with a description of the neutral gas density prior to the discharge initiation in the interelectrode space. (auth)

6821 PLASMA GENERATOR. R. A. Dandl and W. B. Ard, Jr. (to U. S. Atomic Energy Commission). U. S. Patent 3,160,556. Dec. 8, 1964.

A device for producing a hot, stable plasma and for reducing charge-exchange losses therein by providing a plasma blanket about the plasma is described. This blanket is created by connecting a microwave generator to a reflecting cavity within an evacuated enclosure such that the electrons therein are heated at the cyclotron frequency of the electrons along lines of constant magnetic flux. These heated electrons in turn, produce ions, and both ions and electrons move along magnetic field lines to produce the plasma blanket. As some of these ions gain energy from the hot electrons they are confined in the area within the plasma blanket and thus are protected by the blanket from neutral particles outside the blanket. (AEC)

Shielding

Refer also to abstract 5600.

6822 (HMI-B-37) REICHWEITEN SCHWERER TEILCHEN: NEUTRALE ATOME IN ISOTROPER BREMSSUBSTANZ. (KERNRÜCKSTOSS IN FESTKÖRPERN 9). (Ranges of Energetic Atoms in a Stopping Material with Randomly Distributed Atoms. (Nuclear Recoil in Solids 9)). J. Biersack (Hahn-Meitner-Institut für Kernforschung, Berlin). June 30, 1964. 35p. Dep.(mn).

The range of energetic atoms ($E \leq 100$ kev) is calculated assuming that binary elastic collisions with the atoms of the stopping material are the main cause of the slowing down. The atoms of the stopping material are supposed to be randomly distributed and at rest. The Thomas-Fermi-Firsov potential is used to describe the repulsive interaction between the colliding atoms. The results include the stopping power, range, and range straggling as functions of the energy (in generalized coordinates). (auth)

6823 (MLM-1200) GAMMA SHIELDING REQUIREMENTS FOR PLUTONIUM-238 AND POLONIUM-210. K. W. Foster (Mound Lab., Miamisburg, Ohio). May 15, 1964. Contract AT(33-1)-Gen-53. 9p. Dep.; $1.00(cy), 1(mn) OTS.

Gamma shielding requirements were computed for plutonium-238 and polonium-210. Literature values were used for the gamma energies, their relative abundances, and for the mass absorption coefficients of these decay components in various shielding materials. A point source and isotropic radiation were assumed; self-absorption was not considered. For plutonium-238 the greatest shielding thicknesses were required to attenuate the 760-kev component; therefore, the shielding required to reduce the dose rate from this component to less than one mR per hour at one meter was used to compute the total dose rate. The following shielding thicknesses are required to reduce the dose rate from a bare 1-kg plutonium-238 source to less than 2.5 mR per hour at one meter: 1.95 cm lead, 3.77 cm iron, 1.03 cm uranium, and 11.6 cm concrete. The gamma radiation intensities were computed for 100-watt, 1-kilowatt, and 10-kilowatt polonium-210 heat sources. The thicknesses of uranium required to attenuate the 0.803-Mev gamma radiation from each of the above sources to 1000, 100, 10.0, and 1.0 mR per hour at one meter were calculated (e.g., 0.95 cm uranium would reduce the dose rate of a 1000-watt source (54.4 mR) to 10.0 mR per hour at one meter). (auth)

6824 AN EXPERIMENTAL STUDY OF γ-RAY ATTENUATION IN POLYETHYLENE–LEAD SHIELDS. C. A. Bisselle, R. A. Karam, and J. A. Wethington, Jr. (Univ. of Florida, Gainesville). Intern. J. Appl. Radiation Isotopes, 15: 529-39(Sept. 1964).

The shielding efficiency of lead and of polyethylene–lead combinations was studied with radiation from ^{60}Co. Four types of shields of equal surface density were used: lead, polyethylene followed by lead, lead followed by polyethylene, and lamination of polyethylene and lead. Pulse-height spectra of the radiations transmitted through these shields were taken and converted into their respective photon spectra by the inverse matrix technique. From the photon spectra, dose rates in air were calculated. It was found that lamination of polyethylene and lead gave the best shield. Energy deposition ratios in NaI(Tl) obtained directly from the pulse-height spectra agreed with the dose rates in air obtained from the photon spectra. (auth)

6825 EMPIRICAL GAMMA-RAY ALBEDO FORMULA. T. H. Jones, N. E. Scofield, and W. J. Gurney (Naval Radiological Defense Lab., San Francisco). Nucl. Sci. Eng., 21: 115-16(Jan. 1965).

An empirical formula for gamma dose albedo was developed on the basis of differential dose albedo measurements made using ^{137}Cs and ^{60}Co as sources; semi-infinite slab thicknesses of concrete, iron, and aluminum as scattering media; and three angles of incidence. (D.C.W.)

REACTOR TECHNOLOGY

General

6826 (ANL-6944) REACTOR DEVELOPMENT PROGRAM. Progress Report, September 1964. (Argonne National Lab., Ill.). Oct. 15, 1964. Contract W-31-109-eng-38. 97p. Dep.; $3.00(cy), 1(mn) OTS.

Development summaries are presented on boiling water reactors, liquid-metal-cooled reactors, general reactor technology, advanced systems research and development, and nuclear safety. Separate abstracts were prepared for each topic. (J.R.D.)

For abstracts of individual sections see: 6827, 6828, 6829, 6873, and 6874.

6827 (ANL-6944(p.13-52)) LIQUID-METAL-COOLED REACTORS. (Argonne National Lab., Ill.).

Physics experiments with Assembly 45 in ZPR-III are described in which the Doppler effect in PuC-fueled power breeder reactors is being investigated. Operations in ZPR-VI are reviewed. Developments in metallic fuels for fast breeder reactors are reported in U–Pu–fissium combinations and U–Pu–C elements. Mechanical testing Ti–V alloys for use as jacket materials is reported. Data from irradiation testing of fast reactor fuels are reported along with fabrication of DOPPLER test elements. Development of the skull reclamation process is reported, and decladding studies on Ti–V cladding are reviewed. Development of analytical techniques for sodium and coolant cover-gas impurities are described. Operations associated with EBR-II and FARET are reviewed. (J.R.D.)

6828 (ANL-6944(p.53-76)) GENERAL REACTOR TECHNOLOGY. (Argonne National Lab., Ill.).

Summaries are presented on in-core fast-neutron spectroscopy, high-conversion critical experiment, resonance interference, calculation of energy yield by the AX-1 code, ceramics development for high-temperature uses, corrosive properties of Li at high temperatures, ultrasonic testing of high-temperature materials, remote viewing systems, glass fracture by electric discharge, developments on master-slave manipulators, coolant pressure drop, fluidization and volatility separation processes, studies of mobile blanket fuels, plutonium recycle program, and calculation of lattice parameters for Al–Pu lattices. (J.R.D.)

6829 (ANL-6944(p.82-8)) NUCLEAR SAFETY. (Argonne National Lab., Ill.).

Data and information from urania–stainless steel reaction tests in TREAT are reported along with results of metal oxidation-ignition studies, fast reactor safety studies, and other developments with TREAT. (J.R.D.)

Auxiliaries and Components

6830 (GEMP-299) CIRCULATING BALL REACTIVITY CONTROL. Final Report. (General Electric Co. Advanced Technology Services, Cincinnati). Dec. 7, 1964. Contract AT(40-1)-2847. 26p. Dep.; $2.00(cy), 1(mn) OTS.

The development of methods of operating a reactor control rod when sharp bends exist between the poison rod and the drive head is described. The use of poison balls or short spherical-ended segments as control elements, and methods of moving elements of these types, are also discussed. (auth)

6831 (HW-83607) PROGRAM FOR CONTAINMENT SYSTEMS EXPERIMENT. A SUMMARY OF HANFORD LABORATORIES PROGRESS DURING 1964 UNDER GENERAL ELECTRIC AND PROGRAM FOR FUTURE WORK. G. J. Rogers (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 1964. Contract AT(45-1)-1350. 51p. Dep.; $3.00(cy), 2(mn) OTS.

The CSE (Containment Systems Experiment) program will evaluate the effectiveness of selected containment systems in limiting fission product release to the environs under conditions representative of maximum credible accidents for pressurized and boiling water reactors. The effects of the natural processes of agglomeration, deposition, and condensation of steam in attenuating fission product concentration will be determined both in the reactor vessel and the containment vessel. The effectiveness of active and passive safeguards including spray systems, air filter systems, and water pool scrubbing will be evaluated for fission product removal as well as for reduction of postaccident containment pressure. The dynamic effects of large ruptures of high temperature water systems will be investigated as they relate to containment system design and performance, and the relations between air leakage rate tests on containment vessels and the escape of fission products under postaccident conditions will be determined. The program must investigate a range of values for a large number of variables to obtain results which are accurate and general. Simulated fission products will be used to permit rapid progress of testing. Experimental demonstration of the equivalence of fission product and simulant transport is recognized as essential to acceptance of the CSE program results. The development of appropriate simulants by testing their transport behavior against fission products from irradiated UO_2 is underway as part of the supporting research and development effort. The experimental facility is based on a 30,000 ft^3 containment vessel rated for 75 psig. A model drywell, wetwells, and reactor vessel permit tests on a significant engineering scale of a variety of reactor conditions. Representative engineered safeguard systems are provided for tests, along with necessary supporting operational equipment. (auth)

6832 (IITRI-578P21-8) STUDIES OF REACTOR CONTAINMENT. Bimonthly Progress Report, April–May 1964. E. V. Gallagher, comp. (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Contract AT(11-1)-578. 30p. Dep.(mn); $2.00(cy), 1(mn) OTS.

In crushable shield analysis, work was directed toward the debugging of the SWIMM (Stress Waves in Multilayered Media) high speed digital computer code written for the UNIVAC 1105 in FORTRAN. Shock impingement experiments on balsa wood are evaluated. In the coolant decompression experiments and analysis, work consisted of the following activities: completion of modifications of the lifting equipment for operation of the water shock tube under boiling water conditions, refinement of temperature measurement techniques for the fast response Nanmac thermocouples, development and calibration of a technique for measuring the vapor removed from the driver tube, and execution of experiments in the three-dimensional driver vessel. (N.W.R.)

6833 (IITRI-T6042-7) STUDIES OF REACTOR CONTAINMENT. Bimonthly Progress Report, February–March 1964. E. V. Gallagher, comp. (Illinois Inst. of Tech., Chicago. IIT Research Inst.). Contract AT(11-1)-578. 33p. Dep.(mn); $2.00(cy), 1(mn) OTS.

In crushable shield analysis, work was continued on the debugging of the SWIMM (Stress Waves in Multilayered Media) high speed digital computer code written for the UNIVAC 1105 in FORTRAN. Shock impingement experiments on balsa wood are evaluated. In the coolant decompression experiments and analysis, work consisted of the following activities: execution of experiment in the three-dimensional driver vessel and modification of the equipment for operation with vapor initially in the driver. (N.W.R.)

6834 (KR-74) NEW TYPE OF SAFETY AMPLIFIERS FOR REACTORS. Einar Jakobsen (Norway. Institutt for Atomenergi, Kjeller). Oct. 1964. 14p. Dep.(mn).

This report describes a new type safety amplifier circuit used in connection with ionization chambers. The capacity

of the ionization chamber and its coaxial cable is used as a capacitor which is charged through a resistor and discharged as pulses into a trip circuit. The ionization current, caused by the neutron flux, acts as a load resistor across the capacitor, and when this load increases, the pulse frequency to the trip circuit decreases. At a pre-set minimum frequency the trip circuit releases. (auth)

6835 (LFEN-NI-14) ÉTUDE ANALOGIQUE DES PERFORMANCES D'UN SYSTÈME DE PILOTAGE AUTOMATIQUE PAR "TOUT OU RIEN" POUR UN RÉACTEUR NUCLÉAIRE. (Analogic Study of Performances of a "Go-No Go" Automatic Control System for a Nuclear Reactor). G. Chazal and J. Menezes (Portugal. Junta de Energia Nuclear. Laboratorio de Fisica e Engenharia Nucleares, Sacavem). Feb. 10, 1964. 90p. Dep.(mn).

The results of an analog study of the performance of a system proposed for the regulation of the power level of a high-flux reactor are presented, together with the equations used. The response of the reactor and the frequency of intervention of the control rod drive motor for different reactivity perturbations were investigated, together with the effect of the correction network. (D.C.W.)

6836 THERMOCOUPLE SCANNER SYSTEM FOR MSRE /Q-2574/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1156)

Eleven drawings are included for a scanning system that monitors and displays the signals produced by approximately 420 thermocouples in Molten-Salt Reactor Experiment channels. The system may be adjusted to produce an alarm signal when a temperature difference exceeds values from ± 50 to 300°F. The system used a 100 point Hg jet switch as a commutator. The switch is driven by a 1200 rpm synchronous motor. The scanning rate is 2000 points/sec. (P.C.H.)

Criticality Studies

6837 (IDO-17026) DUZIT—ARMF DATA ANALYSIS PROGRAM FOR THE IBM-7040. D. H. Gipson and R. A. Peereboom (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Oct. 1964. Contract AT(10-1)-205. 67p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The program DUZIT processes the data received from the ARMF-I and ARMF-II rod position readout systems. It takes corresponding sample-in and sample-out rod positions and converts them to relative reactivity to obtain the net reactivity worth of a sample relative to the empty reactor. Some of the options available allow one to obtain reactivity data as a function of time or sample concentration, apply additive or multiplicative corrections to the net reactivity worths of a sample, and obtain average reactivity worths of samples. DUZIT is written in FORTRAN for use on an IBM 7040. (auth)

6838 (IDO-17049) AN ENGINEERING TEST PROGRAM TO INVESTIGATE A LOSS OF COOLANT ACCIDENT. T. R. Wilson, O. M. Hauge, G. B. Matheney, and G. B. Homer (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Oct. 1964. Contract AT(10-1)-205. 179p. Dep.; $5.00(cy), 3(mn) OTS.

An engineering test program is presented to investigate a loss of coolant accident for a water-cooled and moderated reactor using a complete nuclear plant. The preliminary design of the reactor and a facility, designated as LOFT, to be used for carrying out the test program is also described. The purpose of the program is to demonstrate the consequences of a loss of coolant accident, to provide quantitative information on the behavior of nuclear plant components and fission products, and to determine the phenomena of principal importance in determining the accident consequences, thereby providing future guidance to the related research and development programs. The reactor is a typical pressurized water reactor capable of operation at 50 Mw(t). The reactor and primary coolant system is mounted on a railroad flatcar and will be installed in a conventional dry containment vessel. The containment contains special provisions for obtaining fission product samples and decontamination. (auth)

6839 (KAPL-M-6123) TET—THERMAL ENERGY TRANSPORT PROGRAM. (KAPL VERSION). K. R. Edgar and T. J. Reno (Knolls Atomic Power Lab., Schenectady, N. Y.). Oct. 1964. Contract W-31-109-eng-52. 49p. Dep.(mn); $2.00(cy), 2(mn) OTS.

The TET computer program provides approximate solutions of the thermal neutron multigroup transport equation in one-dimensional slab geometry. The source and energy exchange kernels may have anisotropic components up to and including the P_3 term. The discrete ordinate representation of the vector flux may have from one to six angles in the forward and backward directions. The exterior boundaries of the problem may be symmetric, periodic, or vacuum. The cross section library is identical to the SWAK thermal cross section library, except for the additional moments of the energy exchange kernels. An optional TRANSWAKRAUM iteration will provide a flux guess for the problem by solving an overlapping two-group approximation. The output of the program includes, for each spatial mesh interval, an energy dependent expansion of the flux in space and angle, the total thermal captures, the total thermal flux, and average cross sections. (auth)

6840 (KAPL-M-6413) SWAKRAUM. A SPATIALLY DEPENDENT THERMAL SPECTRUM PROGRAM FOR THE PHILCO 2000. F. D. Federighi and T. J. Reno, Jr. (Knolls Atomic Power Lab., Schenectady, N. Y.). Oct. 16, 1964. Contract W-31-109-eng-52. 51p. Dep.(mn); $3.00 (cy), 1(mn) OTS.

SWAKRAUM is a general one-dimensional, thermal space-energy code which calculates the thermal spectrum, cross sections averaged over the spectrum, and the thermal flux as a function of position. The calculation is based on either a P-1 or Double P-1 expansion of the Boltzmann equation. The P_0 component of the energy exchange kernel may be any scattering kernel, but the P_1 component must contain no energy transfer. The program assumes that the spectrum everywhere can be represented as a linear combination of a few spectra (the "trial spectra"). The program has a built-in blackness routine, so that calculations may treat discrete poison plates and control rods by thin region theory. The output of the program includes, at each point, the spectrum, the spectrum averaged materials constants, the flux, and the energy integrals of the product of various cross sections and the flux. (auth)

6841 (NAA-SR-9771) MATERIAL BUCKLINGS OF CRITICAL AND SUBCRITICAL URANIUM-CARBIDE-FUELED GRAPHITE ASSEMBLIES. PART I. EXPERIMENT. O. R. Hillig and D. W. Latham (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 1, 1964. Contract AT(11-1)-Gen-8. 71p. Dep.; $1.50(OTS).

A series of critical and subcritical experiments were performed to determine values of material buckling and k_{eff} for graphite assemblies fueled with slightly enriched (3.02 wt %) uranium carbide fuel elements. Lattice arrangements were studied which included control channel mockups for triangular lattice pitches of 9, 11, and 12 inches. Experiments were performed to determine critical mass for two-region (uranium–carbide and uranium-metal-fueled) assemblies and k_{eff} for subcritical uranium–carbide-fueled assemblies. Exponential experiments were carried out to determine material buckling for subcritical assemblies containing uranium carbide fuel elements. Additional assemblies of varying size were used to study diffusion anisotropy and the apparent dependence of material buckling upon assembly size. The exponential studies were corrected for these effects. Material buckling and k_{eff} values were also inferred from the two-region critical mass measurements using four-group theory, and these values were compared to the results obtained from subcritical measurements. The values inferred from the critical mass measurements provided a more consistent set of results. These inferred values also were compared to calculated results. The agreement with results obtained using multigroup theory is very good while the agreement with results from few-group calculations is poor. (auth)

6842 (PWAC-446) TDP—A TWO-DIMENSIONAL PERTURBATION CALCULATION CODE BASED ON TDC,

FOR IBM-7090, DECK B 516. Walter J. Fader (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). Nov. 20, 1964. Contract AT(30-1)-2789. 38p. Dep.; $1.00(cy), 1(mn) OTS.

TDP is a linear perturbation theory code programmed in the FLOCO system for the IBM 7090. The code may be used to calculate changes in k_{eff} for perturbations of the material cross sections in a single region of a reactor configuration calculated by the TDC code. The calculation of neutron prompt lifetime and of effective delayed fraction are TDP options. The forward (regular) and adjoint total fluxes required by TDP are obtained from TDC calculations as binary punched card output. The required forward and adjoint angular fluxes are supplied on tapes written during the TDC calculations. The report consists of: a code description of the calculations performed by TDP; definitions of the TDP parameters and functions; code user's instructions, describing the input and output; and a flow diagram of the TDP flow code with a listing of the TDP symbolic deck and a discussion of each TDP formula. (auth)

6843 (WAPD-TM-373) MAGMA—A PHILCO 2000 PROGRAM FOR THE CALCULATION OF SCATTERING KERNELS, NEUTRON SPECTRA AND FEW-GROUP PARAMETERS FOR THERMAL NEUTRONS. W. W. Clendenin, D. E. George, and B. S. Hamill (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Sept. 1964. Contract AT-11-1-GEN-14. 63p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The MAGMA program for thermal neutron parameters carries out three functions. The first section calculates scattering kernels for particular physical systems; liquid H_2O and the free proton. The second section uses a scattering kernel obtained either in the first section or from another program to determine the energy dependent spectra of the scalar flux, neutron current, and higher components for a particular composition and buckling. These spectra are obtained in one of several optional approximations, P_1, P_3, double-P_1, P_5, or P_{11}, to the transport equation. An additional option in this section permits the calculation of the time decay constant of thermal neutrons corresponding to the absorption and leakage of the system, and the associated neutron spectra. The third section uses the neutron spectra. The third section uses the neutron spectra obtained to compute few-group (ten or fewer) constants for P_1, P_3, double-P_1, or P_5 few-group treatments. This section also calculates, optionally, microscopic cross sections, blackness coefficients, and flux-weighted averages of arbitrary specified functions. (auth)

6844 (WAPD-TM-437) RECAP-3—A MONTE CARLO PROGRAM FOR ESTIMATING EPITHERMAL CAPTURE RATES IN RECTANGULAR OR 60° PARALLELOGRAM GEOMETRY. N. R. Candelore and R. C. Gast (Westinghouse Electric Corp., Bettis Atomic Power Lab., Pittsburgh). Mar. 1964. Contract AT(11-1)-Gen-14. 35p. Dep.; $2.00(cy), 1(mn) OTS.

The calculation of epithermal capture rates in a rectangular or 60° parallelogram geometry system is described in a Monte Carlo FORTRAN program (M0464) for the Philco 2000. The program will permit: 400 regions; 25 different compositions; 10 nuclides including five resonance absorbers; and symmetry, rotational, and a combination of symmetry and rotational boundary conditions. The resonance capture probabilities are calculated using a Σ_a/Σ_T estimator. Smooth and resonance captures are edited separately. All cross section information required is obtained from a magnetic tape of Doppler broadened cross sections generated in RECAP-2. (auth)

6845 (WAPD-TM-482) TXY01—A ONE-GROUP TRANSPORT PROGRAM FOR x-y GEOMETRY. J. H. Bennett (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Oct. 1964. Contract AT-11-1-GEN-14. 17p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The program TXY01 solves the monoenergetic neutron transport equation in a rectangular region. It uses a discrete ordinates method, with provision to use successive overrelaxation to accelerate convergence. The method of differencing, the input and output, and the results of some preliminary parametric studies using the program are described. (auth)

6846 XENON OVERRIDE IN GAS-COOLED REACTORS. I. SKETCHING XENON TRANSIENTS. R. Haworth and R. Hockney (English Electric Co. Ltd., Whetstone, Leics, Eng.). J. Nucl. Energy, Pt. A & B, 18: 601-19(Nov. 1964).

Graphs from which Xe transient reactivity curves can be quickly drawn without the aid of a computer are presented. The data provided apply to step reductions in power from any initial power to any part load in present designs of gas-cooled graphite-moderated natural-U power reactors. The variation of Xe reactivity for a point in the reactor and for two reactor average quantities are included. (auth)

6847 XENON OVERRIDE IN GAS-COOLED REACTORS. II. A SIMPLE THEORY OF SECTOR-ROD MOVEMENT. R. Hockney (English Electric Co. Ltd., Whetstone, Leics, Eng.). J. Nucl. Energy, Pt. A & B, 18: 621-43(Nov. 1964).

A theory is developed that uses graphic correlations previously established for estimation of xenon transients following reactor power reduction to predict the movement of sector control rods after power reductions. (J.R.D.)

6848 EMPIRICAL REPRESENTATION OF THE THERMAL NEUTRON SPECTRA OF SLIGHTLY ENRICHED, URANIUM DIOXIDE FUELED, WATER-MODERATED CORES OF LOW H:28 ATOMIC RATIOS. Jose O. Juliano (Philippine Atomic Energy Commission, Manila). Philippine J. Sci., 93: 161-70(Mar. 1964).

Calculations of the thermal spectra of UO_2 cores for H: U-238 atom ratio of 3:1, 2:1, 1.5:1, and 1:1 at 20°C are reported. The SOFOCATE code was used in the calculations, results of which are included. (J.R.D.)

6849 NUMERICAL METHODS OF REACTOR ANALYSIS. Melville Clark, Jr. and Kent F. Hansen. Nuclear Science and Technology. A Series of Monographs and Textbooks. New York, Academic Press, 1964. 349p. $10.50.

Numerical methods (viz. linear equations, matrix algebra, difference equations, numerical solutions of equations, multigroup diffusion methods, transport methods, and the Monte Carlo method) are reviewed, as applied to the analysis of reactors and critical assemblies. (T.F.H.)

Fuels

Refer also to abstract 6499.

6850 (AED-C-24-01) INFORMATIONS ON NUCLEAR ECONOMICS IN THE UNITED STATES. ECONOMICS OF NUCLEAR FUEL. BIBLIOGRAPHIES. John R. Lamarsh, comp. (New York Univ., New York). July 1964. 147p. Dep.(mn).

A keyword bibliography is presented of the American literature in 1955-1963 on the economics of nuclear fuels. Among the topics covered are costs and prices of ore mining, processing of ores, isotope separation, fuel element fabrication, fuel services, etc. Author and subject indexes are included. (D.L.C.)

6851 (IDO-17056) ANALYSIS OF SAFETY CONSIDERATIONS FOR TRANSIENT TESTING OF PBF PROTOTYPE FUEL RODS IN TREAT. F. K. Clements and E. Feinauer (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Apr. 17, 1964. Contract [AT(10-1)-205]. 38p. (PTR-690). Dep.(mn); $2.00(cy), 1(mn) OTS.

A description of the experiment equipment and an analysis of the safety considerations pertinent to the transient testing of PBF prototype fuel rods in TREAT are presented in this report. The analysis includes an investigation of the nuclear effects of inserting the experiment in the TREAT facility and a summary of the consequences of postulated accident situations. (auth)

6852 A NEW METHOD FOR DETERMINING THE U-235 ENRICHMENT OF FLAT FUEL PLATES. Jose O. Juliano and Pericles Meneses (Philippine Atomic Energy

Commission, Manila). Philippine J. Sci., 93: 149-60(Mar. 1964).

The basis of the method is assignment of the 186-kev gamma radiation to the actinium series (^{235}U) and the 92-kev gamma radiation to both the ^{238}U and actinium series. The enrichment is estimated from the relative intensities of the 186- and 92-kev gammas. (J.R.D.)

6853 FLUX AND PIN-TO-PIN POWER RATIO MEASUREMENTS OF IRRADIATED FUEL FROM FISSION GAS ANALYSIS. Howard S. Dreyer (Lockheed Missiles and Space Co., [Sunnyvale, Calif.]). 17p. (CONF-446-58)

From American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

A method is described for determining the flux in a fuel pin of an element and the pin-to-pin power ratios in an element from the ^{136}Xe content of the fission gas. Results obtained with fuel elements irradiated in the General Electric Test Reactor are discussed. (D.C.W.)

6854 EXPERIMENTAL STUDIES OF THE U^{238} RESONANCE NEUTRON CAPTURE IN A NATURAL URANIUM METAL CLUSTER CONTAINING MODERATING COOLANTS. B. Arcipiani, A. Boeuf, L. Haemers, and S. Tassan (EURATOM, Ispra, Italy). 12p. (CONF-446-67)

From American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

The ^{238}U resonance neutron capture integral of a tightly packed natural uranium metal cluster, with either air or a moderating coolant at room temperature between the rods, was measured by an activation technique. (D.C.W.)

Power and Power-Breeder Reactors

6855 (GA-4706) DESIGN STUDY REPORT FOR TARGET. A 1000-Mw(e) HIGH-TEMPERATURE GAS-COOLED REACTOR. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). [1964]. Contract AT (04-3)-167. 218p. Dep.; $6.00(OTS).

Preliminary designs and cost estimates were prepared incorporating alternative design features for a number of plants utilizing the HTGR system and having an electrical output of approximately 1000 Mw(e). The specifications for these plants were selected in such a manner as to allow comparison of alternative designs for many of the important features of the plant. By comparing these various cases one can see the effect of various features on the total power cost. (auth)

6856 (GA-5700) 40-MW(E) PROTOTYPE HIGH-TEMPERATURE GAS-COOLED REACTOR POSTCONSTRUCTION RESEARCH AND DEVELOPMENT PROGRAM. Summary Progress Report for the Period Ending July 31, 1964. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Oct. 15, 1964. Contract AT(04-3)-314. 18p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The postconstruction research and development program for developing information on the performance of the Peach Bottom Power Reactor is outlined. (N.W.R.)

6857 (GAMD-3877) POISON EQUIVALENT MEASUREMENT OF THE WORTH OF INDIVIDUAL HTGR CONTROL RODS WITHIN A REGION OF INFLUENCE. J. B. Sampson (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Feb. 4, 1963. Contract AT(04-3)-314. 57p. Dep.(mn); $3.00(cy), 2(mn) OTS.

The worth of individual HTGR control rods within a region of influence or cell having a radius of about 23 cm was measured at the center of the HTGR critical assembly. The technique of measurement consisted of observing the two concentrations of poison distributed uniformly through this cell, which led to criticality in the rodded and in the unrodded condition. The critical assembly was loaded so that in the unrodded condition the radial flux was fairly flat, and contained the same poison concentration for a distance of about 20 cm outside the cell as that within the cell. The interpretation was based on a cellular model, the cell having idealized flat flux outer boundary conditions at all energies. Perturbation corrections were made to convert the measured conditions to the idealized conditions. One set of measurements checked the eigenvalue calculation to within 1% for a rodded cell. The rod for this case was of simple geometrical form, and its effect on neutron absorption was calculated by a blackness method. The control swing for this rod was analyzed by correcting to the idealized boundary conditions in two different ways. The values thus calculated for the control swing were 29 and 31%. The agreement between these values can be considerably improved by simulating the flat flux boundary conditions more completely. The method is therefore believed to be a practical way to measure large control swings within ±1%, or within about ±3% of the magnitude of the swing. The change in poison between the rodded and unrodded conditions were observed for several possible rod designs, including those of more complex geometry. A semi-empirical expression was developed to express the control swing in terms of the poison change. (auth)

6858 (HPR-36) IN-LINE USE OF AN ANALOGUE COMPUTER AT HBWR. J. Hannaford and G. Kjaerheim (Norway. Institutt for Atomenergi. OECD Halden Reaktor Prosjekt). Sept. 1964. 50p. Dep.(mn).

An in-line analog computer has been used at HBWR for processing of the raw data from the instrumented fuel assemblies into more meaningful parameters for investigation of the hydraulic behavior of a fuel channel. The experimental techniques and instrumentation are described, and typical results from the different experiments are presented together with computer circuit diagrams. (auth)

6859 (KAPL-3072) REACTIVITY STABILITY OF A BOILING REACTOR. PART 1. A. B. Jones and W. M. Yarbrough (Knolls Atomic Power Lab., Schenectady, N. Y.). Sept. 14, 1964. Contract W-31-109-eng-52. 42p. Dep.(mn); $2.00(cy), 1(mn) OTS.

An analysis was performed and a digital program written for examining the small-signal stability of a boiling nuclear reactor with density-dependent reactivity feedback. The thermodynamics along the axial length of the rectangular coolant channels are described. Different axial shapes of the distribution of power and density coefficients can be applied to various radial core regions. One-mode reactor kinetics is assumed. A simplifying assumption is that the channels are hydraulically uncoupled, i.e., the flow rates at the channel inlets are assumed to be constant in time. (auth)

6860 (NAA-SR-8714) NUCLEAR INSTRUMENT ANOMALIES DURING RISE-TO-POWER TESTING AT THE HALLAM NUCLEAR POWER FACILITY. J. Cashetta (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 13, 1963. Contract AT (11-1)-Gen-8. 47p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Several problems associated with the nuclear instrumentation were discovered during the rise-to-power testing phases of the Hallam Nuclear Power Facility. The problems ranged in severity from the type justifying preventative maintenance to those dictating essential modification. Because of the limited time available for experimentation and investigation, it was not possible to perform a complete analytical study of the problems. The report encompasses the remedial action initiated to provide satisfactory operation of the nuclear instrumentation. (auth)

6861 (NAA-SR-10307) PIQUA NUCLEAR POWER FACILITY OPERATIONS ANALYSIS PROGRAM PROGRESS REPORT NO. 4, JANUARY 1–JUNE 30, 1964. H. S. Cole, D. F. Hausknecht, O. G. Jenkins, Jr., et al. (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 15, 1964. Contract AT(11-1)-Gen-8. 108p. Dep.; $4.00 (OTS).

Full power was first attained on January 27, 1964. After achieving full power, the reactor operated steadily until the first scheduled shutdown on May 21, 1964 for fuel shuffling, maintenance, and a required containment building leak test. As of that date the PNPF had generated 77.7 million kwh of heat (in excess of 21 million kwh of electricity gross), and contributed 40% of the energy generated by the City of

Piqua. The consequential load swinging has resulted in a monthly average capacity factor of 49%. Two major problems were encountered during this operating period: control rod slippage and drive coil circuit failure, and control rod position indicator drift. These items did not cause any major shutdown, and were repaired during the planned shutdown initiated on May 21. (N.W.R.)

6862 REPORTS FROM THE GENEVA CONFERENCE. I. PRINCIPAL TYPES OF REACTORS. Nils Perrin. Ind. At., 8: Nos. 9-10, 56-62(1964). (In French)

Nuclear reactors are grouped into several major categories, depending on whether they are moderated and cooled by light water using enriched uranium as fuel, moderated by graphite with a charge of natural uranium, moderated by heavy water, and fast neutron reactors cooled by sodium. Experimental reactors form a distinct class used as a source of fast or thermal neutrons. The problem of the separation of isotopes, especially deuterium, is touched upon briefly. (tr-auth)

6863 REPORTS FROM THE GENEVA CONFERENCE. IV. RECENT DEVELOPMENTS IN THE PHYSICS OF REACTORS AND POWER REACTORS. Charles R. Symons (Univ. of Birmingham, Eng. and CERN, Geneva). Ind. At., 8: 9-10, 81-90(1964). (In French)

The progress made since the 1958 Geneva Conference in the development of reactor physics is reported. The efforts made to achieve direct transformation of heat into electricity, which is important for space applications, are stressed. The great increase in the number of research reactors, permitting more and more thorough and diversified studies as to their various possibilities and leading to many different applications, are also mentioned. Special attention is given to radioisotopes and their uses. (tr-auth)

6864 REPORTS FROM THE GENEVA CONFERENCE. V. NEW ECONOMIC DATA. Pierre Sevette. Ind. At., 8: Nos. 9-10, 91-5(1964). (In French)

The main conclusions of the Conference in its discussions on new economic data are summarized. It is somewhat illusory to calculate on a planet-wise scale in determining future needs measured against natural resources. Only a study dealing with one form of energy and within the confines of a stated region can give certain indications on the economic feasibility of installing nuclear power plants. The partisans of the three chief systems—heavy water, natural uranium, and enriched uranium—seek to demonstrate that each is already capable of producing electric energy at a price that can compete with that of classical power plants. Despite the uncertainty still surrounding investment costs and sales prices, this is only true in the case of units of the order of 500 Mw, which limits their application to regions of extremely high consumption because of local needs or an interconnecting network. (tr-auth)

6865 PROGRAM FOR STARTUP OF AN ORGANIC MODERATED REACTOR. Angelo di Loreto. Riv. Ing. Nucl., 2: 444-50(May-June 1964). (In Italian)

The start-up program for the Piqua power reactor is reported. The critical loading, post-critical loading, reactivity pressure and temperature coefficients, calibration of the control rods, measurement of the power coefficient, effects of xenon, and attainment of full power are described. (J.S.R.)

6866 ECONOMIC PERSPECTIVES OF EXPERIMENTAL POWER REACTORS. Hans Michaelis. Riv. Ing. Nucl., 2: 455-71(May-June 1964). (In Italian)

The sources of data available to Euratom for the evaluation of the economics of power reactors are indicated, and the problems of the comparison of data from different sources are discussed. The cost basis of power reactors and the costs for the production of electricity are considered. The competitive possibilities of nuclear energy are reviewed. (J.S.R.)

Production Reactors

6867 REVIEW OF A STUDY OF ECONOMIC FEASIBILITY OF NUCLEAR PROPELLED MERCHANT SHIPS. Hans-Livar Aass (Technische Hochschule, Hanover). VDI (Ver. Deut. Ing.) Z., 106: 1611-16(Nov. 1964). (In German)

A detailed investigation was made to determine the economic merits of nuclear-powered merchant ships. Numerical summaries of the relationship between the different factors and their effect on the economic feasibility are presented. (auth)

Propulsion and Space

Refer also to abstract 6863.

6868 (NAA-SR-9871) SNAP CRITICAL ASSEMBLY-4B PHASE III WATER IMMERSION EXPERIMENTS. S. Yee (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 1, 1964. Contract AT (11-1)-Gen-8. 113p. Dep.; $2.25(OTS).

The Phase III SNAP Critical Assembly-4B (SCA-4B) experiments are described. These experiments demonstrate conclusively the effectiveness of: a void-poison sleeve (shipping sleeve) in maintaining a bare core subcritical when it is internally flooded and fully reflected with water; and void-poison filler blocks in maintaining a beryllium-reflected core subcritical when it is submerged in but not internally flooded with water. Experimental data were also provided in support of the subsequent SNAPTRAN 10A/2-3 destruct experiment. (auth)

6869 (NAA-SR-9906) SNAP MERCURY RANKINE PROGRAM SNAP 2 STRUCTURAL EVALUATION PROTOTYPE SYSTEM. (PSM-2). W. B. Gruenberg (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 1, 1964. Contract AT-11-1-GEN-8. 77p. Dep.; $1.65(OTS).

The SNAP-2 (PSM-2, Phase-II) prototype system program is defined. The need for a structural test item is discussed and the resulting objectives presented. A summation of the design, fabrication, and assembly efforts is given. The test program is outlined and some preliminary results are discussed. (auth)

6870 (NP-14462(p.135-47)) NUCLEAR PROPULSION AND POWER GENERATION. (National Aeronautics and Space Administration, Washington, D. C.).

Research and development progress on SNAP-8, nuclear electric power, electric propulsion, and nuclear rockets is summarized. (N.W.R.)

6871 (RTD-TDR-63-3062) TECHNIQUES FOR ELECTRICAL SWITCHING NEAR THE REACTOR OF A NUCLEAR POWERED CARRIER. Edwin C. Hollinger (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Aug. 1963. (AD-422064). $6.60(OTS).

Presented are findings directed to general solutions for problems found in a high-current, multiple-circuit switching requirement where the switch package operates at 300°F in a combined neutron and gamma radiation field. Special design hardware evolving from this task was tested at varied levels of reactor operation. (auth)

6872 S8ER OPERATING EXPERIENCE. V. L. Rooney and J. Marvosh (Atomics International, Canoga Park, Calif.). 10p. (CONF-446-61)

From American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964.

Zero-power, critical, and operating experiments on the SNAP-8 reactor are summarized. Reactivity coefficients, xenon worth, power distribution, and the worth of Na-K in the core were determined. The dynamic and static stability of the reactor was established, and a variety of reactivity effects were investigated. The reactor was operated for 60 days at 450 kw with a core inlet temperature of 1300°F. (D.C.W.)

Research and Test Reactors

Refer also to abstract 6838.

6873 (ANL-6944(p.1-12)) BOILING-WATER REACTORS. (Argonne National Lab., Ill.).

The Borax-V reactor and facility were shut down and the experimental program terminated. Plans and actions related to disassembly of the reactor components are described. Data from Borax-V tests are included from boiling fuel-rod temperature studies along with measurements of boiler inlet velocity and exit void fraction with core PSH-1, reactor subcooling measurements, and reactor physics calculations. (J.R.D.)

6874 (ANL-6944(p.77-81)) ADVANCED SYSTEMS RESEARCH AND DEVELOPMENT. (Argonne National Lab., Ill.).

The fuel and core design for the Argonne Advanced Research Reactor are reviewed. Developments in MHD power generation and regenerative EMF cells are reported. (J.R.D.)

6875 (EUR-1649.f) BOUCLE EN PILE SR 1. (In-Pile Loop SR 1). Y. Gelée and H. Houllier (Société Progil, Lyon). 1964. 25p. Dep.(mn).

The design study, construction, assembly, and testing of an in-pile loop, SR 1, in the Melusine reactor of the CEN at Grenoble, are reviewed. After a schematic account of the progress of the work, a detailed description of the equipment is given. (auth)

6876 (LA-3136-MS) ULTRA HIGH-TEMPERATURE REACTOR EXPERIMENT CORE HEAT-TRANSFER CALCULATIONS. Donald W. McEachern (Los Alamos Scientific Lab., N. Mex.). July 20, 1964. Contract W-7405-eng-36. 31p. Dep.; $2.00(cy), 1(mn) OTS.

Two computer codes were used to calculate the temperature distribution in the UHTREX core. In one code, both heat transfer and coolant flow distribution between the fuel element hole and the eccentric annulus for a single, isolated fuel channel are considered. The other code simultaneously calculates the temperature distribution in a seven-channel vertical wedge of the core with a given flow and power distribution. The single-channel code, VAFLO, was written specifically for UHTREX and has considerable versatility in the selection of parameters that affect temperature and flow. The other is a Group K-4 modification of the HEATING program that was prepared at ASTRA, Inc. Both programs use a finite-difference technique to represent the conservation of energy equation and Gauss-Seidel method for solving the simultaneous equations resulting from the implicit finite-difference representation. Temperature profiles calculated using these two codes are presented and compared with one another. (auth)

6877 (SGAE-G-1/1964) AUSWECHSELVORRICHTUNGEN UND -VERFAHREN AM ASTRA-FORSCHUNGS- UND TESTREAKTOR. (Fuel Replacement Apparatus and Procedure for the ASTRA Research and Test Reactor). M. J. Higatsberger (Osterreichische Studiengesellschaft fur Atomenergie G.m.b.H., Seibersdorf). [1964]. 13p. Dep.

A loading machine was developed and put into operation for the ASTRA reactor. It is used to exchange fuel elements and to introduce and remove reactor experiments or material to be irradiated. Methods of operation are described and diagrams and pictures given. (M.C.G.)

6878 STUDY OF AIRBORNE RADIOACTIVITIES IN THE OPERATION OF A HIGH FLUX RESEARCH REACTOR (CIR). S. D. Soman and P. Abraham (Atomic Energy Establishment, Trombay, India). 30p. (CONF-642-20)

From Health Physics Society, Cincinnati, June 1964.

Studies on the radioactivity in the exhaust air from the 40-Mw Canada India Reactor are described. Gaseous and particulate activities were studied by decay and gamma spectrum measurements. The gaseous activity is due to induced activities like ^{41}Ar and $^{14}CO_2$ and gaseous fission products. The rate of release of ^{41}Ar from the stack was measured to be about 640 C/day at 40 Mw. The rate of production of ^{41}Ar in all the air spaces in the reactor structure is estimated to be 950 C/day. This discrepancy can be explained in terms of static air in the fuel rod annuli, which does not contribute much to the release. The different methods adopted for the estimation of ^{41}Ar are outlined. Radiocarbon produced by different reactions of neutrons with the constituents of air was theoretically estimated to be 7.24 C/yr. A relation is obtained which can be used to estimate the amount of ^{14}C produced in the coolant air of any air-cooled reactor, if the amount of ^{41}Ar produced is measured. The particulate daughters of gaseous fission products—^{88}Rb, ^{89}Rb, ^{91}Sr, ^{91}Rb, ^{138}Cs, ^{139}Ba and ^{140}Ba—were identified on filter paper air samples. A simple form of electrostatic precipitator used to collect daughter products of gaseous fission products is described. The beta decay of particulate activity collected on filter paper air samples from the exhaust system shows the presence of ^{24}Na and some fission product activities. The peaks in the gamma spectrum of the samples correspond to the gamma energies of ^{24}Na and the prominent fission products. The presence of ^{24}Na was confirmed by chemical analysis. These measurements showed that the rates of release of ^{90}Sr and ^{131}I from the CIR stack are 22×10^{-2} and 200 μC, respectively, per day at 40 Mw. ^{24}Na is formed by the activation of aluminum and escapes into the exhaust stream by recoil, while the fission products are presumed to be formed by the fission of the uranium present as an impurity in the aluminum used for the fabrication of components in the reactor structure. (auth)

WASTE DISPOSAL AND PROCESSING

6879 (UJV-1108/64) OBORUDOVANIE DLYA PROTIVOTOCHNOI SORBTSII NA SUSPENZII ESTESTVENNYKH SORBENTOV. (Equipment for a Counterflow Sorption Using Natural Sorbent Suspensions). V. Vesely, I. Napravnik, S. Gaderka, M. Paar, and L. Mazel (Československá Akademie Věd Ústav Jaderného Výzkumu, Řež). [1964]. 14p. Dep.(mn).

A method for countercurrent sorption of radionuclides from aqueous waste, using bentonite and tuff was developed on a laboratory scale. The tuff showed relatively high extraction coefficients, especially for Cs. Values for Sr were lower and depended on Ca ion concentration. An industrial process carried out in conical-bottomed mixers is outlined. (IIC-M.G.)

6880 EXPERIMENTS ON THE BEHAVIOUR OF EFFLUENT EMITTED FROM STACKS AT OR NEAR THE ROOF LEVEL OF TALL REACTOR BUILDINGS. P. O. A. L. Davies and D. J. Moore (Central Electricity Research Labs., Leatherhead, Surrey, Eng.). Intern. J. Air Water Pollution, 8: 515-33(Oct. 1964).

The behavior of effluent emitted from stacks projecting a few feet above the roof level of reactor buildings at Berkeley and Bradwell nuclear power stations was studied using models in a wind tunnel and a water tunnel. Full-scale plumes from these buildings were also observed under a limited range of conditions; the behavior of model and full-scale plumes was similar when the efflux conditions were similar. The experimental work indicated that the assumption of fairly simple effluent distributions for the purpose of calculating long-term γ-dose rates would not lead to serious errors. (auth)

6881 CHEMICAL PROCESSING PLANT, WASTE STORAGE TANKS (Engineering Materials). (Idaho Operations Office, AEC). (CAPE-1147)

Thirty-one drawings are included for 300,000 gal tanks used to store liquid wastes. The tanks are 50 ft ID, 21 ft high, and are constructed of 304L and 347 stainless steel. Domes 8 ft 6 in. in height and constructed of 304L stainless steel are located on top of each tank. The tanks are cooled with heavy wall pipe coils, which hold the waste temperature between 50 and 20°C to limit corrosion and precipitation. The tanks are equipped with secondary containment sumps, emergency vent condensers, alarms, and transfer jets in case of leaks. The tanks have level, specific gravity, temperature, and pressure monitors with appropriate alarms. Activity levels in the storaged wastes range from 10 to 200 β curies and 3 to 60 γ curies per gal. No leaks from storage tanks or piping systems have been detected. (P.C.H.)

GENERAL AND MISCELLANEOUS

6882 (A/CONF.28/P/298) PRIMENENIE IZOTOPOV I ISTOCHNIKOV IZLUCHENIYA V ISSLEDOVANIYAKH V OBLASTI FIZICHESKIKH I KHIMICHESKIKH NAUK. (Applications of Isotopes and Radiation Sources in Physico-Chemical Studies). P. L. Gruzin (U.S.S.R.). May 1964. 20p.

A review is given of current data on applications of isotopes and nuclear emissions in physics and chemistry. The problems of solid state theory, mechanism and kinetics of physicochemical processes, new technological processes, methods of investigation, and means for automatic control of industrial processes are discussed. (R.V.J.)

6883 (HW-68600-44) PLUTONIUM ABSTRACTS. Volume 4, Number 10. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 1, 1964. Contract AT(45-1)-1350. 21p. Dep.; $1.00(cy), 1(mn) OTS.

A total of 38 abstracts is presented which covers new developments in plutonium technology. The abstracts are arranged under the headings biology & medicine, chemistry, health & safety, metallurgy & ceramics, physics, reactor technology, and miscellaneous. (D.L.C.)

6884 (NP-14462) TENTH SEMIANNUAL REPORT TO CONGRESS, JULY 1–DECEMBER 31, 1963. (National Aeronautics and Space Administration, Washington, D. C.). 242p. $1.00(GPO).

A detailed review is presented of NASA accomplishments and progress. Some of the items covered are manned space flight, satellite applications, scientific investigations in space, space power technology, space vehicle systems, aeronautical research, biotechnology and human research, tracking and data acquisition, international programs, basic research programs, informational programs, and management. A separate abstract is prepared for section on nuclear propulsion and power generation. (N.W.R.)

For an abstract of the individual section see: 6870.

6885 (NP-14507) PROJECT HARDHAT—SEISMIC RECORDING, VELA UNIFORM T/190. Preliminary Technical Report. (Texas Instruments, Inc., Dallas). Mar. 15, 1962. Contract AF33(600)-42411. 27p. (VESIAC-3727-VU)

A discussion is given of the work performed for the recording on magnetic tape at three separate stations of seismic data from the Hardhat event. The test station location and the instruments are described, and the recorded data are given. (D.L.C.)

6886 (NP-14510) BASIC TRAVEL TIME AND AMPLITUDE DATA FROM THE GNOME EVENT. D. S. Carder, D. W. Gordon, and J. N. Jordan (Coast and Geodetic Survey, Washington, D. C.). Aug. 1962. 24p. (VESIAC-3322-VU)

Basic seismic data for the Gnome event are presented which were obtained from a study of seismograms from permanent Coast Survey observatories and cooperating university stations. A computer program for locating the epicenter was tested using the data. (D.L.C.)

6887 (NP-14513) NOTE ON COMPUTER DETERMINATIONS OF THE HYPOCENTER OF THE SAHARA EXPLOSION OF MAY 1, 1962. John M. Nordquist (California Inst. of Tech., Pasadena. Seismological Lab.). Oct. 1962. 16p. (VESIAC-4134-VU)

A definite determination of the relative accuracy of the solutions for the various cases requires knowledge of the exact location and time of the event. In the absence of this test, the following observations can be made: (1) All of the plotted epicenters fall within a circle whose radius is less than 25 kilometers. Five of the eight CIT cases with depth unrestrained and five of the six cases calculated with depth held at 1 kilometer fall within a circle whose radius is less than 10 kilometers. This indicates a high degree of consistency among the several samplings of the data. Of particular interest are Cases D3 and F3, based on data from 28 and 21 stations respectively, of which only 8 were common to the two samples; yet, the two epicenters differ by only 7 kilometers. (2) CIT solutions for depth were all erroneous, with impossible negative values ranging from −2.5 to −244 kilometers. These values were approximately seven times as large as the shifts in epicenter obtained by recomputing the cases with depth held constant at one kilometer. (3) In dealing with low-energy events, a criterion for depth of source other than the arrival times of first motion at stations beyond 25° distance from the epicenter is needed. It is better to assume a reasonable depth and solve for epicenter and origin time than to try to solve also for depth with the present hypocenter location programs. (4) For an event of the size of the one considered, arrival times of clear beginnings at twenty stations beyond 25°, adequately distributed in azimuth about the source, are sufficient for determination of epicenter and origin time. (auth)

6888 (NP-14517) ON-SITE CAVITY LOCATION, SEISMIC PROFILING, TATUM SALT DOME, LAMAR COUNTY, MISS. C. B. Forbes, R. A. Peterson, and V. R. McLamore (United ElectroDynamics, Inc., Pasadena, Calif.). Dec. 1961. Project DRIBBLE. 41p. (VESIAC-1158-VU)

An experimental seismic study was conducted at Tatum Salt Dome. This was the preliminary phase of an on-site inspection technique and was done prior to the construction of cavities in the salt dome. Utilizing a special technique for reflection seismic profiling, two lines of control were shot across the proposed cavity sites with one of the lines extending well beyond the limits of the salt. This technique, referred to as seismic focusing profiling (SFP), was developed to optimize the signal-to-noise ratio by means of horizontal stacking of seismic energy from common depth points. (auth)

6889 (POR-1811) EARTH-MOTION MEASUREMENTS. L. F. Ingram (Waterways Experiment Station, Vicksburg, Miss.). Jan. 1964. Project 1.2 [of] OPERATION DANNY BOY. 70p. (WT-1811). Dep.;$3.00(cy), 3(mn) OTS.

The measurements obtained from 31 vertically and horizontally oriented accelerometers and 3 vertically oriented velocity meters are presented and analyzed. The accelerometers and velocity meters were placed in the region extending horizontally from 3 to 610 meters from Surface Zero (SZ). All were placed near the surface (i.e. at depths of about ⅓ meter) except the accelerometer at the 3-meter station which was buried 18.3 meters deep. Peak acceleration values were considerably less than anticipated. Because of low amplifier gain settings used in anticipation of higher signal levels, usable records were obtained on only 22 channels. However, because of the low acceleration levels, close-in measurements (i.e. close to SZ), which were of primary interest, were successfully made. Peak acceleration attenuated approximately as slant range to the minus 5.6 power between 34 and 95 meters slant range, and as slant range to the minus 2.1 power between 95 and 300 meters slant range. Peak vertical acceleration measured by a deeply buried gage at a horizontal range of 3 meters was approximately 5,700 g while the peak vertical acceleration at the surface 7.6 meters from SZ was 1,600 g. Velocity of the compression wave, as calculated from arrival times read from the instrument records, ranged from 5.6 km/sec near the working point to 1.54 km/sec at a horizontal range of 305 meters. The low value at the greater distance indicates that the basalt at the test site was not uniform. Peak particle velocity outside the crater ranged roughly from 8 m/sec at 50 meters horizontal range to 0.17 m/sec at 305 meters horizontal range. Peak particle velocity attenuated as slant

range to the minus 2.1 power between 50 and 306 meters slant range. Peak displacements outside the crater ranged from about 20 cm at 38.1 meters horizontal range to approximately 2 cm at 305 meters horizontal range. (auth)

6890 (SC-R-64-174) RECEIVING PROPERTIES OF BALANCED FOUR-WIRE TRANSMISSION LINES EXCITED BY PLANE-WAVE ELECTRIC FIELDS. C. W. Harrison, Jr. (Sandia Corp., Albuquerque, N. Mex.). June 1964. Contract AT(29-1)-789. 10p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The response of a balanced four-wire transmission line, terminated at the ends in arbitrary values of impedance, to an unwanted signal polarized parallel to the conductors is discussed. The wires are equally spaced on the periphery of a circle (so that the cross section is a square), and the diagonal conductors are electrically paralleled at the ends of the line. Sufficient data are presented to permit two and four conductor transmission lines to be compared on the basis of electrical noise pickup. (auth)

6891 (SC-R-64-1358) THE TRANSMITTING AND RECEIVING CHARACTERISTICS OF A WIDE-ANGLE BICONICAL ANTENNA WITHIN ONE OR TWO IMPERFECTLY CONDUCTING CONCENTRIC SPHERICAL SHELLS. Charles W. Harrison, Jr. (Sandia Corp., Albuquerque, N. Mex.) and Clayborne D. Taylor (New Mexico State Univ., University Park). Aug. 1964. Contract [AT (29-1)-789]. 36p. Dep.(mn); $2.00(cy), 1(mn) OTS.

Sandia Corp. Monograph.

The input impedance and radiation field of a spherically capped wide-angle biconical antenna symmetrically oriented in a spherical shell of arbitrary constitutive parameters and radius are found by solving the boundary value problem. The end caps of the antenna may be insulated from or short-circuited to the shield. The power dissipated in the shell is evaluated. Using the reciprocity theorem, the current in the load impedance of a wide-angle biconical receiving antenna inside a concentric spherical shell is obtained when the electromagnetic field incident upon the shield is a plane wave. (auth)

6892 (SC-TM-64-1208) THE EFFECT OF CONDENSATION RATE ON THE TEXTURAL PROPERTIES OF VACUUM DEPOSITED GERMANIUM FILMS ON HEATED AMORPHOUS SUBSTRATES. L. E. Terry and J. D. Williams (Sandia Lab., Albuquerque, N. Mex.). Oct. 1964. Contract [AT(29-1)-789]. 18p. Dep.(mn); $1.00(cy), 1(mn) OTS.

An investigation has been conducted to determine the effect of condensation rate on the textural properties of germanium films which have been vacuum deposited on heated amorphous substrates. Ranges of condensation rates from 0.2 to 380 Å/sec for various substrate temperatures in the range 25 to 725°C have been investigated as predicted in SC-TM-306-63(14). The [110] textural characteristics produced at low substrate temperatures and low condensation rates can be extended through higher substrate temperatures if the condensation rate is increased. (auth)

6893 (SC-TM-64-1661) FIBER OPTICS — ITS PRINCIPLES AND APPLICATIONS. Robert L. Alvis (Sandia Lab., Albuquerque, N. Mex.). Nov. 1964. Contract AT(29-1)-789. 17p. Dep.(mn); $1.00(cy), 1(mn) OTS.

The history and principles of fiber optics are discussed. Some applications are described; they include uses in testing, photography, oscilloscopes, and remote measurement. Future applications are also considered. (D.L.C.)

6894 (SCL-R-64-148) ENGINEERING USES OF APT. J. D. Gilson (Sandia Corp. Livermore Lab., Livermore, Calif.). Dec. 1964. Contract AT(29-1)-789. 12p. Dep. (mn); $1.00(cy), 1(mn) OTS.

APT (for Automatically Programmed Tools, a numerical language) is already widely used in manufacturing. It is also being used increasingly in engineering studies which use computer techniques (weight, CG, and MI, calculations, thermal and aerodynamic analyses, spring-mass studies, etc.). The advantages of standardizing on APT within the AEC manufacturing complex are described, and the future use of numerical languages in engineering is discussed. (auth)

6895 (SCL-TM-64-86) FOUR BAROMETRIC PRESSURE ENVIRONMENTS FOR AN INDUSTRIAL FRINGE-COUNTING LASER INTERFEROMETER. C. A. Scott, C. J. De Carli, and R. N. Tone (Sandia Corp. Livermore Lab., Livermore, Calif.). Nov. 1964. Contract AT(29-1)-789. 54p. Dep.(mn); $3.00(cy), 2(mn) OTS.

Statistical statements are given of variations in barometric pressure that a pressure-sensitive instrument may meet in four industrial locations — New York, Chicago, Los Angeles and San Francisco. Graphs and tables give means, standard deviations, 90, 95, and 99 percent tolerance limits and similar information for each city. (auth)

6896 (SGC-43R-18) EARTH CURRENTS FROM UNDERGROUND NUCLEAR DETONATIONS. Final Report. (Space-General Corp., El Monte, Calif.). June 4, 1962. Contract AF33(600)-42406. 52p. (VESIAC-1846-VU)

Experimental facilities were established for the GNOME and HARDHAT tests to measure and record the components of the electromagnetic field generated by underground nuclear detonations. In addition an instrumentation system was established at the GNOME site to investigate the characteristics of the plasma generated by the blast to obtain information concerning the nature and source of the electromagnetic field. Data obtained from the tests show that the electromagnetic signals generated by low-yield close-coupled underground nuclear explosions are small in magnitude and cannot be detected above background noise at distances greater than a few kilometers from ground zero. Final conclusions concerning the feasibility of electromagnetic detection of decoupled underground nuclear detonations can be made only after the electromagnetic signals from such explosions have actually been measured. (auth)

6897 (TID-21332) BIOCLIMATIC AND SOILS INVESTIGATIONS IN FOREST ENVIRONMENTS. II. SOILS OF NEOTOMA. Victor L. Riemenschneider (Ohio State Univ., Columbus and Ohio. Agricultural Experiment Station, Wooster). Aug. 1964. Contract AT(11-1)-552. 151p. Dep.(mn); $5.00(cy), 3(mn) OTS.

Results are reported from a study of soil types within the Neotoma Valley, Hocking County, Ohio. The ecological relations between vegetation and soils are discussed. (C.H.)

6898 (TID-21339) PERIPHERAL CIRCULATION AND BONE METABOLISM. (Presbyterian-St. Luke's Hospital, Chicago). [1964]. Contract AT(11-1)-507. 22p. Dep.(mn); $1.00(cy), 1(mn) OTS.

Results are reported from studies on the clearance rate of ^{45}Ca following intravenous injection in dogs; the distribution of ^{51}Cr-labeled erythrocytes in the dog femur and bone marrow after intravenous injection; the determination of the cardiac output and blood flow to the femur of dogs, using ^{85}Sr as a tracer; and tracer studies on blood flow in the femur with a femoral arteriovenous fistula. (C.H.)

6899 (TID-21353) REPORT OF PRELIMINARY ANALYSES CONCERNING NEOTOMA SOLAR RADIATION DATA. Supplement No. 7. Jerry A. Koch and Gareth E. Gilbert (Ohio. Agricultural Experiment Station, Wooster and Ohio State Univ., Columbus). Dec. 1962. Contract AT(11-1)-552. 139p. Dep.(mn); $4.00(cy), 4(mn) OTS.

Measurements were made of the solar radiation at 4 selected sites within the Neotoma Valley, Hocking County, Ohio, from April 1958 through Dec. 1961. The interception of solar radiation by the vegetation of the 4 major habitats was also measured. Data are presented and methods used in field instrumentation, data logging, and data transcription are discussed. (C.H.)

6900 (TID-21354) BIOCLIMATIC AND SOILS INVESTIGATIONS IN FOREST ENVIRONMENTS. VII. SOIL MOISTURE CONDITIONS AT NEOTOMA WITH SPECIAL REFERENCE TO A PERIOD OF DROUGHT. Final Report. Ronald L. Laughlin (Ohio State Univ., Columbus and Ohio. Agricultural Experiment Station, Wooster). Aug. 1964. Contract AT(11-1)-552. 79p. Dep.(mn); $3.00(cy), 2(mn) OTS.

Data are summarized from investigations of soil moisture conditions at 4 major study areas within the Neotoma Valley, Hocking County, Ohio, from 1955 through 1963. Emphasis is placed on soil moisture conditions following a period of drought in 1963. Possible correlations between soil moisture, underlying bedrock, other environmental conditions, and vegetation were studied. (C.H.)

6901 (TID-21394) ARTHROPOD ASSOCIATES OF PLANTS AT THE NEVADA TEST SITE. Biological Series, Volume V, Number 2. Dorald M. Allred and D. Elden Beck (Brigham Young Univ., Provo, Utah). Sept. 1964. Contract AT(11-1)-786. 20p. Dep.(mn); $1.00(cy), 1(mn) OTS.

An ecological study was made of plant-anthropod associations related to the predominant plants in selected plant communities at the Nevada Test Site. Emphasis was placed on the identification of kinds, relative numbers, seasonal incidence, and ecological distribution of the insects relative to the plant communities as well as individual plants of 11 species. (C.H.)

6902 (TID-4025(Rev.1)(Pt.1)(Suppl.3)) TRANSLATION TITLE LIST AND CROSS REFERENCE GUIDE. Frances E. Stratton, ed. (Division of Technical Information Extension, AEC). [nd]. 264p. Dep.; $6.00(OTS).

This supplement lists the unclassified translations received by the Division of Technical Information Extension during the period Jan. 1, 1963 to Dec. 31, 1963. Original source and author indexes are included. (D.L.C.)

6903 OMNIDIRECTIONAL SWITCH. R. A. Randall and D. F. Wilkes (to U. S. Atomic Energy Commission). U. S. Patent 3,161,736. Dec. 15, 1964.

An electrical switch was designed which is responsive to gravimetric acceleration levels less than the acceleration levels due to normal gravitational forces irrespective of the orientation of the body carrying the switch with respect to the earth. A spring loaded mass moves to actuate a contact upon predetermined reduction of the effective weight of the mass due to fractional gravitational forces. The mass is maintained in particular orientation by a gimbal mounting assembly. (AEC)

6904 RAM AIR INFLATED FLOTATION BAG. I. T. Holt and H. E. Widdows (to U. S. Atomic Energy Commission). U. S. Patent 3,161,896. Dec. 22, 1964.

A self-inflated flotation means was designed for use with parachute systems to facilitate recovery of objects that descend into a body of water. The flotation means may comprise a tubular container having a closed upper end and an open lower end. The container may be connected to a parachute above its venting aperture so that air venting from the parachute canopy is passed into the open end of the container to inflate the latter. (AEC)

6905 APPLICATION OF MAGNETIC-EXPANSION PLASMA THRUSTORS TO SATELLITE STATION KEEPING AND ATTITUDE CONTROL MISSIONS. George R. Seikel, David N. Bowditch, and Stanley Domitz (Lewis Research Center, Cleveland). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-677, 24p, $1.00. (CONF-640801-11)

From 4th Electric Propulsion Conference, Philadelphia.

Magnetic-expansion plasma thrustors are devices in which the nondirected electron energy resulting from low-pressure d-c, r-f, or microwave discharges is converted into directed ion energy through expansion in a magnetic nozzle. Performance data are presented for a coaxial hot-cathode d-c thrustor using ammonia or argon propellant. The required magnetic fields are modest. The discharge voltages are sufficiently low to permit direct operation from solar cells with potentially long life cathodes. Performance was determined by mounting the thrustor on a pendulum thrust stand inside a vacuum facility. The experiments determined the necessity of operating the thrustor in a pressure environment of 2×10^{-5} torr or less to obtain pressure-independent performance. Measurements of the force on the magnet showed that, with magnetic nozzle field configurations, the thrust is predominantly electromagnetic, so that electromagnetic thrust vectoring can be used. Weight comparisons are made with other possible systems for a 1500-pound synchronous communication satellite. The electric systems considered operate at submillipound thrust levels directly from a light solar cell array. A hybrid electric system is considered which uses electric thrustors that can be vectored 2° to meet the total effective impulse requirement for station-keeping (8167 lb-sec/yr). These 2° vectorable thrustors can also meet 58% of the 1580 pound-seconds per year required for attitude-control, the remainder being provided by a cold ammonia gas jet system. Such a hybrid system has a lower initial weight because only six electric thrustors and a minimum weight of solar cells are required to meet most of the impulse requirement. Use of magnetic expansion thrustors in this hybrid system results in estimated system weights that are competitive with those using other types of electric thrustors. (auth)

6906 DEVELOPMENT OF A 3-KILOWATT RESISTOJET. Stewart Bennett, K. F. Connors, and Kenn E. Clark (AVCO Corp., Wilmington, Mass.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-672, 27p, $1.00. (CONF-640801-12)

From 4th Electric Propulsion Conference, Philadelphia.

A 3-kw resistojet thrustor was operated for a 293-hr period. The specific impulse level with hydrogen propellant was 840 sec, and the efficiency was 67%. Metallographic analyses of test elements lead to the tentative conclusion that contact between boron nitride insulation and tungsten heater elements should be avoided, as was done in the test thrustor. A nozzle analysis was performed to select the expansion area ratio and conical divergence angle; the effects of boundary layer buildup on the effective area ratio and of shear forces were included. (auth)

6907 FURTHER EXPERIMENTAL INVESTIGATIONS OF A CESIUM HALL-CURRENT ACCELERATOR. Clyde O. Brown and Edward A. Pinsley (United Aircraft Corp., East Hartford, Conn.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-697, 30p, $1.00. (CONF-640801-14)

From 4th Electric Propulsion Conference, Philadelphia.

The performance of an annular Hall-current accelerator using cesium as the propellant was investigated. Thrust and ion current data were obtained with a target thrust balance. Thrust densities of 0.5 mlb/cm^2 were measured at cesium flow rates equivalent to 3.7 amp and at a specific impulse of 1600 sec. Ion current densities in excess of 100 mamp/cm^2 were obtained at cesium flow rates approaching the limit of the test facility. Electron backflow was observed at about 52% of the total accelerator current at the higher mass flows and specific impulses. (D.C.W.)

6908 ELECTRON BOMBARDMENT HEATING FOR ELECTROTHERMAL PROPULSION. K. E. Starner and W. R. Grabowsky (Aerospace Corp., El Segundo, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-673, 28p, $1.00. (CONF-640801-22)

From 4th Electric Propulsion Conference, Philadelphia.

The technique of high-voltage, low-current electron bombardment heating for the heat transfer thrustor was investigated. The electron bombardment approach was shown to have inherent advantages for space application and to lack several restrictions found with resistance heating methods. A tantalum, electron bombardment-type gas heater was built to study thrustor operation. Steady-state gas temperatures up to 2700°K were produced with argon at a voltage-to-current ratio greater than 50. The device functioned successfully for a total operating time of approximately 50 hr. It was found that the electrical characteristics of the heater were adequately predicted by the Langmuir-Child law for space-charge limited emission. Possible causes of some electrical instabilities experienced during the tests are discussed. (auth)

6909 THE DEVELOPMENT OF A REGENERATIVELY COOLED 30 kw ARC-JET ENGINE. James P. Todd and Ronald E. Sheets (Giannini Scientific Corp.,

Santa Ana, Calif.). New York, American Inst. of Aeronautics and Astronautics, 1964, Paper No. 64-671, 21p, $1.00. (CONF-640801-23)

From 4th Electric Propulsion Conference, Philadelphia.

The development of a 30-kw regeneratively cooled arc-jet engine is outlined. The engine was operated continuously for 500 hr at an average specific impulse of 1013 sec and an average thrust of 0.745 lb. The engine is described, together with the test facility; and its performance is summarized. (D.C.W.)

CORPORATE AUTHOR INDEX

This index contains entries for this period for all report literature and, in addition, for certain published literature items for which it is felt that a corporate approach is especially desirable, e.g., symposia, conference proceedings, and meetings.

Each entry under a corporate author is a shortened version of the title of the publication, followed by the *NSA* volume and abstract number. Report numbers are given in parentheses.

The phrase "Progress report" is abbreviated as "Prog. rpt.," permitting a more rapid and complete alphabetical arrangement of the titles without changing the location of the progress report titles in relation to the other titles.

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Because of problems involving the mechanical preparation of this index, all accent marks are omitted. The following changes in spelling have been introduced to reduce some of the confusion which might result from omitting the accents:

ä	becomes	ae
ö		oe
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SUBJECT INDEX

Main entries in this index are generally specific materials, things, and processes. These are followed by modifiers that describe the properties of, and processes applied to, the main entries.

The number preceding the colon is the *NSA* volume number, and the number following is the abstract number. The designation (R) following the abstract number indicates that the abstract is of a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. References to report numbers, where appropriate, are included after the abstract number of the citation. Published literature (journal article or book) is indentifiable by the absence of a report number.

The user should bear in mind that the ideas presented in the original literature, rather than key words, have been indexed. The indexers have tried to select what seemed the most probable and logical place to look for typical information. Since it is not possible to anticipate where a user would look for information, numerous cross references are included to assist him in his search.

Experience in using an index of this type will be the best guide in obtaining the desired information, and a consideration of synonymous or closely related terms will prove valuable.

Information must be so indexed as to be of the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use, nor to the general class headings that include the specific headings. For example, information on the treatment of thyroid disease with I-131 would be indexed under Thyroid Diseases and under Iodine Isotopes I-131, but not necessarily under Radiotherapy. A study of the effects of x radiation on hair would be indexed under both X Radiation and Hair.

The broad, general class headings are used only for general information or for comprehensive reports or articles.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings or, in some cases, subheadings; e.g., Amino Acids rather than Acids, amino; Helium Isotopes He-4 rather than Helium — isotopes He-4 or Helium — He-4 isotopes. Note, however, that in some cases modifying terms are used parenthetically in preference to a more direct type of entry which would result in the scattering of information. Organic compounds, however, are usually entered in the index in the inverted form so that substituted compounds can be listed near the parent compound; e.g., Benzene, Bromo- rather than Bromobenzene. In general, the style of nomenclature used is that of *Chemical Abstracts*, except that some items listed in that publication as subheadings are elevated to form part of the main heading; e.g., Butyric Acid, Methyl Ester rather than Butyric Acid — methyl ester.

Alphabetization

Main headings are arranged according to the widely accepted word-by-word alphabetic system. A parenthetic qualifier following a main heading is disregarded in alphabetizing unless there are two or more headings identical except for the parenthetic qualifier, in which case the qualifier determines the order. Headings involving Greek letters are arranged as if the names of the letters were spelled out, e.g., Mesons (π), Mesons (ξ).

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed in the direct form, listing cations in the order of increasing valence in the case of polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., Sodium Aluminum Silicates and Potassium Sodium Sulfates.

Multicomponent Systems

Multicomponent alloys, except well-known trade names are indexed under each element in the alloy.

Example: Aluminum–Chromium Alloys are indexed

ALUMINUM ALLOYS
Al–Cr ...
CHROMIUM ALLOYS
Al–Cr ...

Well-known alloys such as Hastelloy are indexed directly. Cross references appear in the index cumulations. Multicomponent systems of elements are indexed similarly.

Example: Silicon–Tungsten Systems are indexed

SILICON SYSTEMS
Si–W ...
TUNGSTEN SYSTEMS
Si–W ...

Multicomponent systems of compounds are similarly indexed under the compound.

Physical States of Materials

Specification of the physical state of the material, if other than normal, is included in the modifying phrase.

Modifying Phrases (Subheadings)

Whenever it appears that such information would be useful, descriptive phrases (modifiers), rather than ordinary subheadings, are used under the main headings to give a better indication of the material covered in an abstract. Such phrases are written so that the idea considered most important is presented first. However, when using this index, the reader is advised to scan all modifiers under a main heading to determine whether any abstracts in addition to the most obvious should be consulted for the desired information. Many of the modifiers are designed to be read in inverted order or to be read with the main heading inserted at the position of the comma in order to obtain a meaningful phrase; e.g., Uranium — allotropic transformation temperatures of, effect of cooling rate on is read "effect of cooling rate on allotropic transformation temperatures of uranium." In many cases, the prepositions have been omitted from such phrases provided no ambiguity results from the omission.

For entries concerned with physics, if the modifier does not indicate whether the reference is experimental or theoretical, a symbol E or T or E/T is given.

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U. S. Reports. Many reports of U. S. Government agencies other than the AEC can be obtained by the public in the same manner as AEC reports. The availability of these reports is given when known. If availability is not shown, inquiries should be directed to the Clearinghouse for Federal Scientific and Technical Information. Inquiries concerning "NP" reports should be by title and author rather than by report number.

Non-U. S. Reports. Many reports of atomic energy establishments of other countries are deposited in the libraries listed on the inside covers of each issue of *NSA*.

Additionally, the following countries have made their reports available as indicated.

AUSTRALIA

Australian Atomic Energy Commission Research Establishment. Available upon request from the Library, Australian Atomic Research Establishment, Private Mail Bag, Sutherland, New South Wales, Australia.

BELGIUM

Centre d'Étude de l'Énergie Nucléaire. Available upon request to individuals and organizations, from the Centre d'Étude de l'Énergie Nucléaire (CEN), 31, Rue Belliard, Bruxelles, Belgium.

CANADA

Atomic Energy of Canada Limited. For sale by the Technical Information Officer, Atomic Energy of Canada Limited, Chalk River, Ontario, Canada. Copies are also deposited in libraries in the United Kingdom.

National Research Council of Canada. Available from the National Research Council of Canada, Ottawa 2, Ontario, Canada.

DENMARK

Atomic Energy Commission Research Establishment, Risø. Available on exchange from the Library, Danish Atomic Energy Commission, Risø, Roskilde, Denmark. Also for sale by Jul. Gjellerup, Booksellers, 87 Sölvgade, København K., Denmark.

Danatom. Available on loan from Research Establishment, Risø, Roskilde, Denmark. Copies are available from Danatom, Aurehøjvej 2, Hellerup, Denmark.

FRANCE

Commissariat à l'Énergie Atomique. Inquiries for reports numbered 1-2199 should be addressed to Commissariat à l'Énergie Atomique, Service Central de Documentation, Centre d'Études Nucléaires de Saclay, Boite Postale No. 2, Gif-sur-Yvette (S. et O.), France. Reports numbered 2200 and above are available from La Documentation Francaise, 16 Rue Lord-Byron, Paris VIII, France.

Service Central de Protection contre les Rayonnements Ionisants. Copies are available from Ministère de la Santé Publique, Service Central de Protection contre les Rayonnements Ionisants, B. P. n° 35–LE VESINET (S. et O.), France.

GERMANY

Deutsches Elektronen-Synchrotron DESY. Copies are available from Deutsches Elektronen-Synchrotron Desy, Dokumentation, 2000 Hamburg-Gr. Flottbek 1, Notkestieg 1, Germany.

Kernforschungsanlage. Copies may be ordered from Zentralbibliothek der Kernforschungsanlage Jülich, Jülich, Bundesrepublik Deutschland.

Hahn-Meitner-Institute für Kernforschung. Available without charge from Hahn-Meitner-Institute für Kernforschung Berlin, Bibliothek, Glienicker Strasse 100, 1 Berlin 39, Germany. Copies are deposited in many national nuclear centers in the world.

Johann-Wolfgang-Goethe Universität, Frankfurt Am Main, Institut für Kernphysik, (IKF). Copies are available from Gmelin Institut, 40-42 Varrentrappstrasse, Frankfurt (Main), West Germany.

ISRAEL

Israel Atomic Energy Commission. Available without charge from Ministry of Defence/Atomic Energy Commission, Soreg Research Establishment, Yavne, Israel. Copies are deposited in libraries in Israel and in other countries.

ITALY

Centro Informazioni Studi Esperienze (CISE). For sale at CISE Press Office, Casella Postale 3986, Milano, Italy. Copies are deposited in libraries in Italy.

Comitato Nazionale per l'Energia Nucleare. Copies are available from Comitato Nazionale per l'Energia Nucleare, Divisione Affari Internazionali e Studi Economici, Ufficio Pubblicazioni, Via Belisario, 15, Roma, Italy.

JAPAN

Japan Atomic Energy Research Institute (JAERI). Available from the Staff Supply Cooperative of Japan Atomic Energy Research Institute (JAERI), 1-1 Tamura-Cho, Shiba, Minato-Ku, Tokyo, Japan. Copies are deposited in depositories in Tokyo, Nagoya, and Osaka.

Nagoya University. Copies are available from Research Information Center, Institute of Plasma Physics, Nagoya University, Nagoya, Japan.

University of Tokyo. Available free of charge from Institute for Nuclear Study, University of Tokyo, Tanashi-Machi, Kitatama-gun, Tokyo, Japan.

NETHERLANDS

Reactor Centrum Nederland. For sale by Reactor Centrum Nederland, 112 Scheveningseweg, 's-Gravenhage, The Netherlands. Copies are deposited in university libraries in Holland and in many national nuclear centers in the world.

NEW ZEALAND

Institute of Nuclear Sciences. Copies are available from Librarian, Institute of Nuclear Sciences, D.S.I.R., Private Bag, Lower Hutt, New Zealand. Copies are deposited in other countries.

NORWAY

Forsvarets Forskningsinstitutt. Copies available from Norwegian Defence Research Establishment, Library, P. O. Box 25, Kjeller, Norway.

Institutt for Atomenergi. "KR" reports are available on an exchange basis from the Library, Institutt for Atomenergi, Box 40, Kjeller, Norway. Other series are not generally available to the public.

Norwegian Reactor School. Copies are available from The Library, Institutt for Atomenergi, P. O. Box 40, Kjeller, Norway.

PAKISTAN

Atomic Energy Center. Copies are available from Atomic Energy Center, P. O. Box 658, Lahore, (West Pakistan).

POLAND

Biuro Pelnomocnika Rzadu do Spraw Wykorzystania Energii Jadrowej. (CLOR). Copies are available from Pełnomocnik Rządu d/s Wykorzystania Energii Jądrowej, Ośrodek Informacji Naukowej, Technicznej i Ekonomicznej, Warszawa, PK i N, Poland.

SPAIN

Junta de Energia Nuclear. "JEN" reports are available without charge from Servicio de Documentation, Junta de Energia Nuclear, Ciudad Universitaria, Madrid (3), Spain.

SWEDEN

Aktiebolaget Atomenergi. "AE" reports are for sale from Aktiebolaget Atomenergi, Library Section, Box 43041, Stockholm 43, Sweden. Bibliographies and literature surveys of the VDDIT- series may be obtained from Aktiebolaget Atomenergi, Information Office, Scientific and Technical Information, Box 43041, Stockholm 43, Sweden. Other series are not generally available to the public. Organizations in the atomic energy field may obtain copies from Aktiebolaget Atomenergi. Microcopy of AE reports is available from the International Documentation Centre, Tumba, Sweden.

SWITZERLAND

CERN European Organization for Nuclear Research. Available without charge from CERN European Organization for Nuclear Research, Geneva 23, Switzerland. Copies are deposited in libraries in 13 countries.

Eidgenössisches Institut für Reaktorforschung. "EIR" reports are available from Eidgenössiches Institut für Reaktorforschung, c/o Bibliothek, Würenlingen/Ag, Switzerland.

TURKEY

Turkish Atomic Energy Commission. Copies are available free of charge from T.A.E.C., Çekmece Nuclear Research Center, P. O. Box 1, Airport, Istanbul, Turkey.

UNITED KINGDOM

United Kingdom Atomic Energy Authority. Some reports are for sale in the United States by the British Information Service (BIS), 845 Third Avenue, New York, N. Y. 10022. United Kingdom reports generally may be purchased from Her Majesty's Stationery Office, London. Copies not for sale by Her Majesty's Stationery Office may be purchased in microcopy form from Micro Methods Limited, East Ardsley, Wakefield, Yorks, England. Report copies are deposited in a large number of libraries in England.

Conferences

Beginning with Volume 19, Number 1, new receipts of conference proceedings as well as individual papers from conferences will be included in this index. When a paper is received from a conference a distinctive number will be assigned to the conference in the form CONF-year-month-sequence. Individual papers will be numbered with this basic "CONF" number and in addition each will carry a further sequence number. For example, the first paper received from a conference held in January 1965 would be numbered CONF-650101-1. Conference proceeding from which no individual papers have been received will be similarly numbered with a basic number. When proceedings are abstracted the abstract will appear at the point of the basic "CONF" number for the conference. Since all information on conferences will be included in this Report Number Index the subject heading CONFERENCES will be discontinued with Volume 19, Number 1.

Abbreviations Used in Availability Column

AECL	For sale by Atomic Energy of Canada Ltd., Chalk River, Ontario, Canada.
BIS	For sale by British Information Service, 845 Third Avenue, New York, N. Y. 10022
Dep.	AEC reports: Full-size copy is on deposit in the depository libraries both inside and outside the United States. These reports are also for sale by Microcard Editions, Inc., Accounting and Shipping Department, West Salem, Wisconsin 54669.

	Non-AEC reports: Full-size copy on deposit in the depository libraries in the United States only.
Dep.(mn)	Same as for Dep., except copy is in micronegative (microfiche) form.
DSIR	For sale by the National Lending Library for Science and Technology (D.S.I.R.), Boston Spa, Yorkshire, England.
DTI Extension	Available from the U. S. Atomic Energy Commission, Division of Technical Information Extension, P. O. Box 62, Oak Ridge, Tennessee 37831.
EM	Blueprints and Microcopy of AEC engineering drawings are available from Clearinghouse for Federal Scientific and Technical Information, U. S. Department of Commerce, Springfield, Virginia 22151. Current prices of the CAPE- packages may be obtained from this address. TID-4100, available from the Division of Technical Information Extension, P. O. Box 62, Oak Ridge, Tennessee 37831, contains information on all the CAPE- packages for sale.
Gmelin	Available at a nominal charge and under the AED- number shown from Atomic Energy Documentation Center, Gmelin Institute, 40-42 Varrentrappstrasse, Frankfurt (Main), West Germany.
GPO	For sale by the Superintendent of Documents, Government Printing Office, Washington, D. C. 20402.
HMSO	Her Majesty's Stationery Office, London.
IAEA	Available from the International Atomic Energy Agency.
JCL	For sale by the Special Libraries Association Translation Center, John Crerar Library, 35 West 33rd Street, Chicago, Illinois 60616.
LC	For sale by the Library of Congress, Photoduplication Service, Washington, D. C. 20540.
NAS	National Academy of Sciences, National Research Council, Washington, D. C. 20418.
NRC	For sale by the National Research Council of Canada, Ottawa, Ontario, Canada.
ORINS	Available on interlibrary loan from the Library, Oak Ridge Institute of Nuclear Studies, Post Office Box 117, Oak Ridge, Tennessee 37831.
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UKAEA, London	Available from United Kingdom Atomic Energy Authority, 11 Charles II Street, London, S. W. 1.
USGS	Available free of charge from the U. S. Geological Survey, Washington, D. C. 20242.

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298	19-6882	
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AAEC-TM–	**(Australian)**	
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421518	19-6381	See AFCRL-63-723
421842	19-6587	See RM-3830-PR
422064	19-6871	See RTD-TDR-63-3062
422146	19-6066	$5.60(OTS)
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449836	19-6240	See ASD-8-170(V)
450079	19-6239	See ASD-8-108(VI)
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450679	19-5838	
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607269	19-6738	See RLE-TR-426
607601	19-6006	See AFWL-TDR-64-67
607682	19-6277	See ML-TDR-64-205
607742	19-6292	See ASD-TDR-62-719(Pt.II)
607864	19-6484	See APL-TDR-64-120
608041	19-6297	See ML-TDR-64-176
608043	19-6253	See ML-TDR-64-269
608061	19-6488	See PWA-2369
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7560	19-6078	Nucl. Sci. Eng., 21: 79-89(1965)
7959	19-5696	Radiation Res., 23: 537-50(1964)
7959-R	19-5696	See BNL-7959
8088	19-6079	Nucl. Sci. Eng., 21: 90-105(1965)
8307	19-6708	Phys. Rev., 136: B1830-8(1964)
8361	19-6161	Rev. Sci. Instr., 36: 48-54(1965)
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90	19-6069	See EURAEC-1084
CLM-P–	**(British)**	
38	19-6783	J. Appl. Phys., 36: 29-34(1965)
41	19-6797	Phys. Fluids, 7: 1987-95(1964)
44	19-6799	Phys. Fluids, 7: 2006-11(1964)
CONF-179–	**(American Chemical Society Radionuclidic Exchange on Soils, Minerals, and Resins, Philadelphia, Apr. 1964)**	
13	19-5814	ORINS. Gmelin, AED-CONF-64-033-37
CONF-407–	**(Electro Chemical Society, Toronto, May 1964)**	
8	19-6289	ORINS. Gmelin, AED-CONF-64-060-14
CONF-417–	**(American Physical Society Meeting, Pasadena, Calif., Dec. 1963)**	
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CONF-425–	**(Conference on Nonfissile Metals for Nuclear Reactors, Bologna, Dec. 1963)**	
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CONF-446–	**(American Nuclear Society 10th Annual Meeting, Philadelphia, June 1964)**	
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CONF-471–	**(American Physical Society 5th Annual Meeting, San Diego, Calif., Nov. 1963)**	
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CONF-481–	**(American Physical Society Annual Meeting, New York, Jan. 1964)**	
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CONF-512–	**(American Society for Testing and Materials 67th Annual Meeting, Chicago, June 1964)**	
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CONF-543–	**(American Physical Society 1964 March Meeting, Philadelphia, Mar. 1964)**	
17	19-6377	ORINS. Gmelin, AED-CONF-64-028-27
19	19-6376	ORINS. Gmelin, AED-CONF-64-028-29
CONF-546–	**(Conference on Analytical Chemistry and Applied Spectroscopy, Pittsburgh, Mar. 1964)**	
2	19-6179	ORINS. Gmelin, AED-CONF-64-014-18
CONF-555–	**(International Symposium on Surface Contamination, Gatlinburg, Tenn., June 1964)**	
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10	19-6062	ORINS. Gmelin, AED-CONF-64-083-19
14	19-6123	Dep.(mn); $1.00(cy), 1(mn) OTS; Gmelin, AED-CONF-64-083-20
CONF-571–	**(American Chemical Society 148th National Meeting, Chicago, Aug.–Sept. 1964)**	
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10	19-6139	ORINS. Gmelin, AED-CONF-64-082-37
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7	19-6479	ORINS. Gmelin, AED-CONF-64-093-30
8	19-6171	ORINS. Gmelin, AED-CONF-64-093-29
9	19-5919	ORINS. Gmelin, AED-CONF-64-093-11
17	19-6168	ORINS. Gmelin, AED-CONF-64-093-15
CONF-651–	**(9th International Conference on Low Temperature Physics, Columbus, Ohio, Aug. 31–Sept. 4, 1964)**	
16	19-6617	ORINS. Gmelin, AED-CONF-64-140-6
CONF-654–	**19-2907 (American Nuclear Society Meeting, 19-6030 San Francisco, Nov. 30–Dec. 3, 1964)**	
CONF-668–	**(Electron Microscope Society of America 22nd Annual Meeting, Detroit, Mich., Oct. 1964)**	
4	19-6250	See GAT-T-1219(Rev.1)
CONF-715–	**(13th Annual Conference on Applications of X-Ray Analysis, Denver, Aug. 12–14, 1964)**	
6	19-6414	ORINS. Gmelin, AED-CONF-64-139-9
CONF-754–	**(International Business Machines Medical Symposium, Poughkeepsie and Upton, N. Y., Oct. 9, 1964)**	
5	19-5603	See BNL-8641
CONF-799–	**(11th Annual Nuclear Science Symposium, Philadelphia, Oct. 28–30, 1964)**	
6	19-6182	See BNL-8633
CONF-806–	**(3rd European Regional Conference on Electron Microscopy, Prague, Aug. 26–Sept. 3, 1964)**	
2	19-6246	See EUR-1834.e
CONF-640101–	**19-5739 (Scintillation Scanning in Clinical Medicine Symposium, Winston-Salem, N. C., Jan. 30–31, 1964)**	
CONF-640601–	**19-6265 (Conference on New Technology, Cleveland, June 4–5, 1964)**	
CONF-640701–	**(International Symposium on Magnetohydrodynamic Electrical Power Generation, Paris, July 6–11, 1964)**	
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CONF-641001–	**(Symposium on Radiochemical Methods of Analysis, Salzburg, Austria, Oct. 19–23, 1964)**	
1	19-5830	ORINS
2	19-5829	ORINS
4	19-5815	ORINS
6	19-5823	ORINS
7	19-5826	ORINS
9	19-5833	ORINS
10	19-5836	ORINS
11	19-5827	ORINS
12	19-5832	ORINS
13	19-5837	ORINS
16	19-5831	ORINS
18	19-5828	ORINS
19	19-5822	ORINS
21	19-5834	ORINS
22	19-6001	ORINS
24	19-5821	ORINS
26	19-6207	ORINS
28	19-5817	ORINS
30	19-5816	ORINS
32	19-5825	ORINS
35	19-5824	ORINS
39	19-5819	ORINS
41	19-5820	ORINS
45	19-6238	ORINS
47	19-5835	ORINS
50	19-5818	ORINS
COO–		
119-230	19-6124	Dep.(mn); $2.00(cy), 1(mn) OTS
498-42	19-6662	Nucl. Phys., 63: 305-22(1965)
1277-7	19-6440	Dep.(mn), $1.00(cy), 1(mn) OTS
1371-2	19-6544	Phys. Rev., 136: B1624-32(1964)
DMIC–	**(Non-AEC)**	
206	19-6245	$2.00(OTS)
DP–		
939	19-6225	Dep.; $2.00(OTS)
DUBNA REPORTS	**(Russian)**	
See JINR (Russian)		
ER–	**(Misc.)**	
7352	19-6364	See NP-14443
ETR–	**(Belgian)**	
165	19-5993	See NP-14447
EUR–	**(European Atomic Energy Community)**	
1649.f	19-6875	Dep.(mn)
1808.f	19-6726	See CEA-R-2456
1831.e	19-6145	Dep.(mn)
1834.e	19-6246	Dep.(mn)
1847.i	19-6247	Dep.(mn)
1886.f	19-5768	Dep.(mn)
2109.f	19-6248	Dep.(mn)
2168.e	19-5769	Dep.(mn)
EURAEC–		
1084	19-6069	Dep.(mn); $3.00(cy), 2(mn) OTS
1104	19-6070	Dep.(mn); $1.00(cy), 1(mn) OTS
1111(Pt.1)	19-6249	Dep.(mn); $1.00(cy), 1(mn) OTS
1113	19-6213	Dep.(mn); $1.00(cy), 1(mn) OTS
1143	19-6067	See BAW-3238-4
1145	19-6073	See NYO-3114-3
1206	19-6242	See BMI-1690
1229	19-6256	See NCSC-2663-18
1253	19-6026	See GEAP-4728
F–	**(Misc.)**	
B1979-3	19-6302	See NYO-2994-3
FTD-MT–	**(Non-AEC)**	
64-407	19-6112	OTS
FZK–	**(Non-AEC)**	
188-2	19-6360	
GA–	**(Misc.)**	
4706	19-6855	Dep.; $6.00(OTS)
5084	19-6341	Nature, 204: 371-2(1964)
5700	19-6856	Dep.(mn); $1.00(cy), 1(mn) OTS
GAMD–	**(Misc.)**	
3877	19-6857	Dep.(mn); $3.00(cy), 2(mn) OTS
GAT-T–		
1219(Rev.1)	19-6250	Dep.(mn); $1.00(cy), 1(mn) OTS
GEAP–	**(Misc.)**	
4540	19-5770	Dep.(mn); $1.00(cy), 1(mn) OTS
4728	19-6026	Dep.(mn); $2.00(cy), 1(mn) OTS
GEMP–	**(Misc.)**	
299	19-6830	Dep.; $2.00(cy), 1(mn) OTS
GEST–	**(Misc.)**	
2037	19-6486	$1.00(OTS)
Hmi-B–	**(German)**	
28	19-6214	Dep.(mn)
37	19-6822	Dep.(mn)
HNS–		
1229-49	19-6091	Dep.(mn); $2.00(cy), 1(mn) OTS
HPR–	**(Norwegian)**	
36	19-6858	Dep.(mn)
HW–		
68600-44	19-6883	Dep.; $1.00(cy), 1(mn) OTS
71589	19-5986	Dep.(mn); $1.00(cy), 1(mn) OTS
74036	19-5987	$1.00(cy), 1(mn) OTS
75537	19-5988	Dep.(mn); $1.00(cy), 1(mn) OTS
80011	19-5856	Inorg. Chem., 3: 1738-40(1964)
80309	19-6294	Dep.; $2.00(OTS)
80913	19-6125	Dep.(mn); $1.00(cy), 1(mn) OTS
82152	19-6361	Dep.; $3.00(cy), 2(mn) OTS
82825	19-6274	Dep.; $3.00(OTS)
83164	19-6362	Dep.; $2.00(cy), 1(mn) OTS
83284	19-6215	Dep.(mn); $1.00(cy), 1(mn) OTS
83474	19-5771	Dep.; $2.00(OTS)
83605	19-6126	Dep.; $3.00(cy), 2(mn) OTS
83607	19-6831	Dep.; $3.00(cy), 2(mn) OTS
83723	19-6092	Dep.; $2.00(cy), 1(mn) OTS
HW-SA–		
3046(Rev.)	19-5853	Electrochem. Technol., 2: 239-44(1964)
3498	19-5697	Radiation Res., 23: 551-63(1964)
3729	19-5604	Dep.(mn); $3.00(cy), 2(mn) OTS
IA–	**(Non-AEC)**	

Report No.	Abstract No.	Availability
927	19-5842	Dep.(mn)
933	19-5772	Dep.(mn)
981	19-6183	Dep.(mn)
IAEA-R–	**(International Atomic Energy Agency)**	
19	19-5601	
IDO–		
17022	19-6184	Dep.; $2.00(OTS)
17025	19-6631	Dep.; $1.00(OTS)
17026	19-6837	Dep.(mn); $3.00(cy), 2(mn) OTS
17043	19-6185	Dep.; $2.00(OTS)
17049	19-6838	Dep.; $5.00(cy), 3(mn) OTS
17056	19-6851	Dep.(mn); $2.00(cy), 1(mn) OTS
IITRI–	**(Misc.)**	
578P21-8	19-6832	Dep.(mn); $2.00(cy), 1(mn) OTS
T6042-7	19-6833	Dep.(mn); $2.00(cy), 1(mn) OTS
IHS-R–	**(New Zealand)**	
24	19-6093	Dep.(mn)
IPP–	**(German)**	
1/16	19-6727	Dep.(mn)
4/11	19-6728	Dep.(mn)
6/4	19-6729	Dep.(mn)
6/7	19-6730	Dep.(mn)
6/8	19-6731	Dep.(mn)
6/14	19-6732	Dep.(mn)
6/15	19-6733	Dep.(mn)
6/18	19-6734	Dep.(mn)
6/21	19-6735	Dep.(mn)
6/26	19-6736	Dep.(mn)
IS–		
854	19-6268	Dep.; $2.00(cy), 1(mn) OTS
977	19-6251	Dep.; $2.00(OTS)
984	19-6252	Dep.; $1.00(OTS)
JINR–	**(Russian)**	
E-1813	19-6515	Dep.(mn)
P-1715	19-6516	Dep.(mn)
P-1778	19-6517	Dep.(mn)
P-1779	19-6441	Dep.(mn)
P-1795	19-6632	Dep.(mn)
P-1796	19-6633	Dep.(mn)
P-1800	19-6634	Dep.(mn)
P-1807	19-6518	Dep.(mn)
P-1814	19-6519	Dep.(mn)
P-1830	19-6635	Dep.(mn)
JPRS–	**(Non-AEC)**	
26742	19-6379	$4.00(OTS)
27451	19-6271	$2.00(OTS)
27558	19-6219	$1.00(OTS)
JüL–	**(German)**	
182-PP	19-5843	Dep.(mn)
189-VW	19-6105	Dep.(mn)
193-PP	19-6565	Dep.(mn)
194-ST	19-5726	Dep.(mn)
200-PP	19-6186	Dep.(mn)
K–		
1624	19-6127	Dep.; $3.00(cy), 1(mn) OTS
KAPL–		
3032	19-6295	Dep.(mn); $1.00(cy), 1(mn) OTS
3062	19-6296	Dep.(mn); $2.00(cy), 1(mn) OTS
3067	19-6071	Dep.(mn); $1.00(cy), 1(mn) OTS
3072	19-6859	Dep.(mn); $2.00(cy), 1(mn) OTS
KAPL-M–		
6123	19-6839	Dep.(mn); $2.00(cy), 2(mn) OTS
6413	19-6840	Dep.(mn); $3.00(cy), 1(mn) OTS
6416	19-6236	Dep.(mn); $1.00(cy), 1(mn) OTS
6422	19-6007	Dep.(mn); $2.00(cy), 1(mn) OTS
KFK–	**(German)**	
232	19-5989	Dep.(mn)
KR–	**(Norwegian)**	
73	19-6072	Dep.(mn)
74	19-6834	Dep.(mn)
LA–		
3133	19-5773	Dep.; $1.00(cy), 1(mn) OTS
3136-MS	19-6876	Dep.; $2.00(cy), 1(mn) OTS
3139	19-6275	Dep.; $3.00(OTS)
3143-MS	19-6487	Dep.; $2.00(cy), 1(mn) OTS
3154	19-6276	Dep.; $1.00(OTS)
3159	19-5774	Dep.; $1.00(OTS)
LA-DC–		
6012	19-6546	Phys. Rev., 136: B1693-1702(1964)
LA-tr–		
64-30	19-6307	Dep.(mn); $1.10(fs), $0.80(mf) JCL
LADC–		
3882	19-6644	J. Inorg. Nucl. Chem., 26: 1769-93(1964)
6115	19-6329	J. Electrochem. Soc., 111: 1404-8(1964)
6278	19-6469	Phys. Rev., 137: A27-34(1965)
LFEN-NI–	**(Portuguese)**	
14	19-6835	Dep.(mn)
MATT–		
281	19-6801	Phys. Fluids, 7: 2015-16(1964)
ME–	**(Misc.)**	
5-62-3	19-6028	See TID-21379
63-1-1	19-6010	See TID-21356
MITNE–	**(Misc.)**	
50	19-5990	Dep.(mn); $2.00(cy), 1(mn) OTS
54	19-5991	Dep.(mn); $1.00(cy), 1(mn) OTS
ML-TDR–	**(Non-AEC)**	
64-176	19-6297	$1.00(OTS)
64-205	19-6277	$4.00(OTS)
64-269	19-6253	$2.00(OTS)
MLM–		
1200	19-6823	Dep.; $1.00(cy), 1(mn) OTS
1201	19-5992	Dep.; $1.00(cy), 1(mn) OTS
1205	19-6254	Dep.; $1.00(OTS)
MND-P–		
2640(Rev.2)	19-6226	Dep.(mn); $2.00(cy), 1(mn) OTS
MSAR–	**(Misc.)**	
64-126	19-6298	Dep.(mn); $2.00(cy), 1(mn) OTS
NAA-SR–		
8213	19-6278	Dep.; $1.25(OTS)
8714	19-6860	Dep.(mn); $2.00(cy), 1(mn) OTS
9731	19-5941	Dep.; $3.00(OTS)
9771	19-6841	Dep.; $1.50(OTS)
9871	19-6868	Dep.; $2.25(OTS)
9906	19-6869	Dep.; $1.65(OTS)
10307	19-6861	Dep.; $4.00(OTS)
NAA-SR-Memo–		
8662	19-6620	Dep.(mn); $5.00(cy), 3(mn) OTS
9619	19-6363	Dep.(mn); $1.00(cy), 1(mn) OTS
NAEC-AML–	**(Non-AEC)**	
1759	19-6299	$1.10(OTS)
NAS-NS–	**(Misc.)**	
3007(Rev.)	19-5977	Dep.; $0.75(OTS)
NASA-SP–	**(Misc.)**	
58	19-5942	$1.75(OTS)
5015	19-6265	Conference on New Technology, Lewis Research Center, Cleveland, Ohio, June 4–5, 1964. National Aeronautics and Space Administration, Washington,

Report No.	Abstract No.	Availability D. C. $1.00(GPO)
NASA-TN–	**(Misc.)**	
D-2513	19-6255	$0.50(OTS)
D-2554	19-6383	$3.00(OTS)
NASA-TR–	**(Non-AEC)**	
R-212	19-6737	$1.50(OTS)
R-218	19-6636	$1.00(OTS)
NASA-TT–	**(Non-AEC)**	
F-263	19-6263	$0.50(OTS)
NCSC–	**(Misc.)**	
2663-18	19-6256	Dep.(mn); $1.00(cy), 1(mn) OTS
NIRL-R–	**(British)**	
69	19-6146	Dep.(mn); $0.60(BIS), 3s. (HMSO)
NMI–	**(Misc.)**	
7292	19-6300	Dep.(mn); $3.00(cy), 2(mn) OTS
NOLTR–	**(Non-AEC)**	
64-46	19-6637	$0.50(OTS)
NP–	**(AEC File No. for Non-AEC Reports)**	
14263	19-5759	Dep.(mn)
14390	19-6094	Dep.(mn)
14439	19-6269	
14443	19-6364	
14447	19-5993	Dep.(mn); $2.00(cy), 1(mn) OTS
14462	19-6884	$1.00(GPO)
14506	19-6095	
14507	19-6885	
14508	19-6384	
14510	19-6886	
14511	19-6096	
14513	19-6887	
14516	19-6107	
14517	19-6888	
14518	19-6586	
14524	19-6108	
14525	19-6109	
14526	19-6110	
14527	19-6111	
14532	19-6087	
14534	19-6385	
14535	19-6257	
14537	19-6258	
14541	19-6638	
14546	19-6386	
14569	19-6387	
NRL–	**(Misc.)**	
6164	19-6097	Dep.(mn); $1.00(cy), 1(mn) OTS
6165	19-6128	Dep.(mn); $1.00(cy), 1(mn) OTS
NUMEC–		
3428-3	19-6301	Dep.(mn); $1.00(cy), 1(mn) OTS
3432-3	19-6259	Dep.(mn); $1.00(cy), 1(mn) OTS
NYO–		
2310-3	19-5943	See RRL-147
2994-3	19-6302	Dep.(mn); $3.00(cy), 1(mn) OTS
3114-3	19-6073	Dep.(mn); $1.00(cy), 1(mn) OTS
3291-1	19-5598	Dep.(mn); $1.00(cy), 1(mn) OTS
ORNL–		
3711	19-6305	Dep.; $3.00(OTS)
3719	19-5994	Dep.; $2.00(OTS)
3720	19-5844	Dep.; $2.00(OTS)
3735	19-6129	Dep.; $3.00(OTS)
ORNL-P–		
109	19-6661	Nucl. Phys., 63: 286-304(1965)
157	19-6547	Phys. Rev., 136: B1730-40(1964)
190	19-5984	Rev. Sci. Instr., 36: 75-7(1965)
209	19-6675	Nucl. Phys., 63: 513-19(1965)
252	19-5893	Phys. Rev., 137: A138-42(1965)
253	19-6160	Rev. Sci. Instr., 36: 44-7(1965)
304	19-6704	Phys. Rev., 136: B1719-29(1964)
ORNL-TM–		
1012	19-5760	Dep.(mn); $2.00(cy), 1(mn) OTS
ORO–		
622	19-6147	Dep.; $2.00(OTS)
PATENTS	**(British)**	**3s. 6d. each, U. K. Patent Office**
967,367	19-6175	
971,050	19-6002	
971,105	19-6140	
971,141	19-6063	
971,188	19-6003	
971,414	19-6064	
971,504	19-5922	
971,747	19-5923	
971,770	19-6176	
971,902	19-6085	
971,930	19-6290	
971,941	19-6177	
971,978	19-5976	
971,980	19-6065	
972,044	19-5924	
972,083	19-6430	
972,152	19-5925	
972,191	19-6178	
PATENTS	**(U. S.)**	
3,158,468	19-6004	
3,160,470	19-5926	
3,160,471	19-5927	
3,160,566	19-6821	
3,160,817	19-6179	
3,161,462	19-5928	
3,161,463	19-6005	
3,161,701	19-6291	
3,161,736	19-6903	
3,161,896	19-6904	
3,162,509	19-5929	
3,162,527	19-5930	
PATENTS	**(U.S.S.R.)**	
163,683	19-6212	
POR–	**(Non-AEC)**	
1811	19-6889	Dep.; $3.00(cy), 3(mn) OTS
PTR–		
690	19-6851	See IDO-17056
PWA–	**(Non-AEC)**	
2369	19-6488	$5.00(OTS)
PWAC–	**(Misc.)**	
446	19-6842	Dep.; $1.00(cy), 1(mn) OTS
R–	**(Misc.)**	
2295	19-6213	See EURAEC-1113
RFP–		
419	19-5775	Dep.; $2.00(cy), 1(mn) OTS
449	19-6027	Dep.; $0.50(cy), 1(mn) OTS
469	19-6008	Dep.; $1.00(cy), 1(mn) OTS
RISO–	**(Danish)**	
48(Suppl.1)	19-6260	Dep.(mn)
85	19-6098	Dep.(mn)
86	19-6099	Dep.(mn); Jul. Gjellerup, 87, Solvgade, Copenhagen K, Denmark
87	19-6100	Dep.(mn); Jul. Gjellerup, 87, Solvgade, Copenhagen K, Denmark
89	19-6261	Dep.(mn)
RLE-TR–	**(Non-AEC)**	
426	19-6738	$2.00(OTS)
RM–	**(Misc.)**	
3830-PR	19-6587	$5.60(OTS)
4225	19-6588	

Report No.	Abstract No.	Availability
RR-TR–	**(Non-AEC)**	
64-4	19-6630	See AD-601793
RRL–		
147	19-5943	Dep.(mn), $1.00(cy), 1(mn) OTS
RS–		
430	19-6009	See SWRI-1228-40
RT-GEO–	**(Italian)**	
(64)-13	19-6148	Dep.(mn)
RTD-TDR–	**(Non-AEC)**	
63-3062	19-6871	$6.60(OTS)
SC-DC–		
64-1463	19-6378	Dep.(mn); $3.00(cy), 2(mn) OTS
SC-R–		
64-174	19-6890	Dep.(mn); $1.00(cy), 1(mn) OTS
64-1358	19-6891	Dep.(mn); $2.00(cy), 1(mn) OTS
64-1359	19-6237	Dep.; $1.00(cy), 1(mn) OTS
SC-RR–		
64-979	19-6489	Dep.; $1.00(cy), 1(mn) OTS
64-1679	19-6101	Dep.; $1.00(cy), 1(mn) OTS
SC-TM–		
64-1208	19-6892	Dep.(mn); $1.00(cy), 1(mn) OTS
64-1661	19-6893	Dep.(mn); $1.00(cy), 1(mn) OTS
SCL-R–		
64-148	19-6894	Dep.(mn); $1.00(cy), 1(mn) OTS
SCL-TM–		
64-86	19-6895	Dep.(mn); $3.00(cy), 2(mn) OTS
SGAE-CH–	**(Austrian)**	
6/1964	19-6149	Dep.(mn)
7/1964	19-5944	Dep.
SGAE-G–	**(Austrian)**	
1/1964	19-6877	Dep.
SGAE-IB–	**(Austrian)**	
IA-5/1964	19-5776	Dep.(mn)
SGC–	**(Non-AEC)**	
43R-18	19-6896	
SLAC–		
25(Pt.II)	19-6520	Dep.; $3.00(cy), 2(mn) OTS
SWRI–		
1228-40	19-6009	Dep.(mn); $3.00(cy), 2(mn) OTS
TEI–		
855	19-6217	Dep.(mn); $1.00(cy), 1(mn) OTS
TID–		
3579	19-5628	Dep.; $2.00(OTS)
4025(Rev.1) (Pt.I)(Suppl.3)	19-6902	Dep.; $6.00(OTS)
6728	19-6306	Dep.(mn); $2.00(cy), 1(mn) OTS
20036	19-5996	J. Inorg. Nucl. Chem., 26: 1991-2003(1964)
20080	19-5777	Dep.; $4.00(OTS)
20446	19-5619	J. Pharm. Sci., 53: 1186-8(1964)
20778	19-6551	Phys. Rev., 136: B1783-7(1964)
20813	19-6707	Phys. Rev., 136: B1803-6(1964)
20959	19-6548	Phys. Rev., 136: B1756-60(1964)
21153	19-5945	Dep.(mn); $2.00(cy), 1(mn) OTS
21199	19-6218	Dep.; $2.00(OTS)
21331	19-6074	Dep.(mn); $4.00(cy), 3(mn) OTS
21332	19-6897	Dep.(mn); $5.00(cy), 3(mn) OTS
21339	19-6898	Dep.(mn); $1.00(cy), 1(mn) OTS
21344	19-5761	Dep.(mn); $4.00(cy), 2(mn) OTS
21353	19-6899	Dep.(mn); $4.00(cy), 4(mn) OTS
21354	19-6900	Dep.(mn); $3.00(cy), 2(mn) OTS
21356	19-6010	Dep.(mn); $3.00(cy), 2(mn) OTS
21368	19-5931	Dep.(mn); $1.00(cy), 1(mn) OTS
21374	19-6150	Dep.(mn); $3.00(cy), 2(mn) OTS
21379	19-6028	Dep.(mn); $4.00(cy), 2(mn) OTS
21381	19-5932	Dep.(mn); $5.00(cy), 3(mn) OTS
21382	19-5946	Dep.(mn); $6.00(cy), 4(mn) OTS
21383	19-5947	Dep.(mn); $6.00(cy), 5(mn) OTS
21386	19-5995	Dep.(mn); $5.00(cy), 3(mn) OTS
21387	19-6639	Dep.(mn); $2.00(cy), 1(mn) OTS
21388	19-5948	Dep.(mn); $4.00(cy), 2(mn) OTS
21389	19-5949	Dep.(mn); $3.00(cy), 2(mn) OTS
21391	19-5933	Dep.(mn); $3.00(cy), 2(mn) OTS
21392	19-5629	Dep.(mn); $3.00(cy), 2(mn) OTS
21394	19-6901	Dep.(mn); $1.00(cy), 1(mn) OTS
TM–	**(Misc.)**	
3815-67	19-6269	See NP-14439
TT–	**(Canadian)**	
64-41999	19-6379	See JPRS-26742
64-51700	19-6271	See JPRS-27451
64-51806	19-6219	See JPRS-27558
UCD–		
34P80-2	19-5630	Dep.; $5.00(cy), 3(mn) OTS
UCLA–		
12-527	19-5703	Radiation Res., 23: 620-9(1964)
UCRL–		
7522	19-6337	Metals Eng. Quart., 4: 8-17(1964)
7931	19-6388	Dep.; $2.00(OTS)
7955	19-6466	Phys. Rev., 137: A1-3(1965)
11610	19-6420	Rev. Sci. Instr., 36: 64-5(1965)
11649	19-5934	Dep.(mn); $5.00(cy), 3(mn) OTS
12015	19-6159	Rev. Sci. Instr., 36: 41-4(1965)
UCRL-Trans–		
1132(L)	19-6739	Dep.(mn); $3.00(cy), 2(mn) OTS; $7.60(fs), $2.57(mf) JCL
1154	19-5605	Dep.(mn); $1.60(fs), $0.80(mf) JCL
UJV–	**(Czechoslovakian)**	
1108/64	19-6879	Dep.(mn)
UR–		
653	19-5725	Dep.; $3.00(cy), 2(mn) OTS
875-43	19-6670	Nucl. Phys., 63: 449-65(1965)
USBM-RC–		
1135	19-6262	Dep.; $2.00(cy), 1(mn) OTS
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